2012

Fire Management Strategy

for Tanintharyi Nature Reserve



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1. Introduction

TNR was established and legally notified by MOF (now MOECAF) on the 30th of March 2005 with the aim at conserving tropical rainforests and their constituent biodiversity in the Taninthayi region of southern Myanmar. This is the first collaborative project between Ministry of Forestry (MOF) represented by the Forest Department International Corporates (Corporate and Social Responsibility) namely, the Moattama Gas Transportation Company Limited (MGTC) representing Total E&P Myanmar (TEPM) and Taninthayi Pipeline Company LLC (TPC) representing PETRONAS Carigali along with Myanmar Oil and Gas Enterprise (MOGE) representing Ministry of Energy (MOE) by using funds derived from the operation of MGTC and TPC gas production facilities to support the establishment and long-term operation of Taninthavi Nature Reserve.

It is situated at the Dawei District, Taninthayi Division, between the Dawei River and the Myanmar-Thailand border, between latitudes 14° 20' 50" and 14° 57' 55" North, and between longitudes 98° 5' 10" and 98° 31' 32" East.

It consists of the eastern part of Heinze / Kaleinaung Reserve Forest 85, 728 ha (211,836 acre) and Luwaing Reserve Forest 84273 ha (208,240 acre). This area encompasses approximately 1,700 square kilometers (657 square miles) or

170,000 hectare (420,070 acre) of primarily pristine tropical evergreen forest and some mixed deciduous forest. The size of this area is comparable to the largest protected areas in other countries of the region and the extensive forests make it a significant addition to both Myanmar's Protected Areas System (PAS) and the regional protected areas network (Core unit, TNR Operational Management Plan, 2009).

The climate in the TNR area is seasonal and tropical monsoon type. The site is one of the most abundant rainfall areas in Myanmar. Average annual rainfall from 2001 to 20011 is 5352 mm. The average temperature range is 25.69° C with the hottest in March and the coldest in January (Personnel Communication, TEPM).

Most areas in TNR are of high elevation and the range of the terrain varies from 15 m above sea level in lowlands to 1400 m at the ridge of Thai border. The steep slope in most parts of the area is greater than 37%. The mountain range runs from north to south while the slope rises from west to east towards the ridge top and is oriented to the western aspect. The area is generally described as rolling to hilly along the border areas and most of the southern portions considered as rugged to very steep mountainous. Geological formation in the Heinze / Kaleinaung reserved forest consists of granite intrusions and weathering of granite gives rise to gravelly soil on which giant evergreen forest is found. The soil type in TNR falls into the yellow and red brown forest soil zone.

It is quite evident that throughout Heinze / Kaleinaung reserve, the 500' contour may be the dividing line above which natural forest, mostly giant evergreen prevails; the crop below consists of old *ponzo* (i.e., the after-growth in an area that has been subjected to shifting cultivation) of 30 years of age and over (Smith, 1927). Giant evergreen occupies practically, all ground between elevations of 500 and 3000 feet. Sub-evergreen and moist deciduous forests cover almost all ground below an elevation of 500 feet. They are all accessible but practically all old *ponzo*. Hill evergreen prevails on the top of ridges and spurs above an elevation of about 3000 feet. It is entirely confined to the Thai frontier, being inaccessible and practically nothing of commercial value.

From biodiversity conservation point of view TNR lies within "Biounit 5d (Uga, 2002), and Tenasserim-South Thailand semi-evergreen moist forest region which is nationally important, regionally significant and globally outstanding. The area has been identified by WWF as one of the threatened terrestrial ecosystems of the world and particularly as this area is connected to the Western Forest Complex of Thailand, it will be of significance for one of the important transborder Protected Areas in Asia.

The use of fires to clear land for permanent or shifting agriculture and settlements by local communities is wide spread in South East Asia including Myanmar. Whether such fires can be controlled or not depends on various aspects such as the biophysical conditions of the forest, the presence of fuel load or the availability of fire breaks.

Generally, shifting cultivation practices are assumed to be a kind of activity that destroys forest resources, without fully understanding its underlying concept. Controlled fire use has been practiced by indigenous people with the intension that it appears to focus on avoiding damage to neighboring fields or villages and also protecting forests.

However, it is often difficult to distinguish between forest lost due to clearance for shifting cultivation and loss due to escaped fires. Thinn (1999) had stated about forest fires in Myanmar that;

"slash-and-burn cultivation (Taungya) has been an age-old practice with many ethnic races who live in the mountainous area of the country, and is still being practiced widely. This is the main cause behind forest fires occurring in Myanmar. However, as it is carried out merely on a subsistence scale, and as the natural forests buffers the areas, the spreading of fire to adjoining area is minimal. Besides, burning is normally done under close supervision of the villagers."

2. Problem Statement

There have been no proper records concerning forest fire incidences in the TNR area for the last 6 years. As over 77% of forest areas in the TNR consist of evergreen forests which have a closed canopy that protects from wind and due to the moist microclimate and heavy rainfall, the risk of fire at TNR is expected to be quite low. In fact, forest fire may cause to some extent of negative impact on biodiversity of TNR, especially in the dry season. As fire prone deciduous forests are situated at the fringes of the TNR boundary that may likely be the source of fire hazard for TNR. The dry and moist deciduous forests are the only ones which burn annually (Smith, 1927). It was already stated in the working plans of Heinze/Kalienaung Reserve (1926-27 to 1935-36) that practically all forests below an elevation of approximately 500 feet had been subjected to taungya (shifting cultivation) with the result that the main form of growth currently existing is *ponzo*. It is essential for promoting community involvement and education about the negative impacts of forest fire. It is also necessary to initiate management and development of fire use to improve outcomes and reduce the incidence of agricultural/ taungya burnings beyond the intended areas by the

development of appropriate fire management plans particularly in and around the location of high biodiversity value, adjacent to 'Village Use Zone'. Special control measures may be needed to access, plan and implement such that the long term integrity of TNR and its core and buffer zone is assured.

3. Objectives

The objectives of the study are to review practices of forest fire use in TNR and to make recommendations for improvements where appropriate. During this review, attention should be given to find out whether Community Based Fire Management (CBFiM) approach applied throughout the South East Asia region since 2000, be appropriate and applicable for the effective management of fire in TNR based on the following approaches:

- To study on main causes and incidences of forest fire in TNR
- To design and conduct research on fire management strategies
- To develop appropriate fire management plans
- To conduct fire management workshops and trainings to local people and staff
- To educate local communities to raise awareness on the dangers of anthropogenic fire and its impacts

4. Community Involvement and Management of Forest Fires in South East Asia

The forest fires of 1997 and 1998 create enormous ecological damage and human suffering and help focus world attention on the problem. Large-scale forest fires in South East Asia, particularly in Indonesia have grabbed worldwide attention (Rowell and Moore, 2000) Fires are common in most deciduous seasonal forests in South East Asia and so called 'fire-climax' pine forests in Myanmar, Thailand, Lao PDR, Cambodia, Vietnam, Philippines and Indonesia (Goldammer, 1997) The issues to be addressed are complex and cut across many interests, sectors, communities, nations and regions. It is quite certain that action take place when fires are burning with little attention being given to underlying causes. As the problem of forest fire lies beyond the capacity of national and regional organizations to handle alone, a multiple stakeholder approach is currently attempted, particularly in the South East Asian region. This approach is based on popular participation, public awareness, and policy outreach programs in connection with fire related issues.

Studies were made on three areas of interests in South East Asia:

- Community based fire management
- Legal and regulatory aspects of forest fires, and

• The economics of fire use in South East Asia

This review is concerned with community involvement in and management of fires in South East Asia. Successful experiences of local community-based approaches to fire prevention and control are highlighted and analyzed. The main intention is to enable local communities to actively engage and prevent uncontrolled burning.

Community based forest fire management stems from the occurrence of recent catastrophic forest fires with the intention to find out alternative ways to prevent future outbreaks of similar cases. The use of fires to clear land for permanent agriculture and settlements by local communities is wide spread in South East Asia. Whether such fires can be controlled depends on aspects such as:

- Fuel load
- Biophysical conditions of the forest , and
- The availability of firebreaks.
- The local community's interest in the forests

It was observed in South East Asia that uncontrolled fires among shifting cultivators is due to the fact that traditional systems practiced by their ancestors are not adapted. That led to a knowledge gap as elders are no longer passing

down their experiences to the younger generation. The revival of some of the lost practices should also need consideration. Inexperienced migrants, who are not traditional shifting cultivators, have allowed fires to escape. Nonetheless, it is often difficult to distinguish between forest loss due to clearance for shifting cultivation and loss due to escaped fires. It is still debatable to find out the actual status on whether shifting cultivators are careful in fire management or they are the destroyers of the forest as seen as a primitive system. Nevertheless, it is often difficult to distinguish between forest loss due to clearance for shifting cultivation and loss due to escaped fires.

Controlled fire use appears to be an initiative taken by indigenous people, with the intention of avoiding damage to neighboring fields or villages and to protect forests. Hence, 'community cohesion', secure land tenure and 'attachment' to local resources are important for controlled fire use.

People rely on fire as a land clearing and preparation tool in shifting cultivation so as to:

- Burn over-mature plantations to re-establish new plantations, such as rubber plantations in Indonesia (Gouyon, 1999)
- Improve access to facilitate the collection of honey, rattan and burnt fallen wood (Chuntanaparb et al., 1993)

- Hide evidence of illegal logging (e.g. in Thailand, Fehr, 1993) or to divert attention from such sites (e.g. in Indonesia)
- Increase production of resin (e.g. in Cambodia, Emerson, 1997) and mushrooms (e.g. in Cambodia, Baird, 2000). Burning of undergrowth apparently improves certain mushroom production. Fire can also remove dried resin in *dipterocarps* and ensure better flow of resin
- Flush animals from their hideouts or encourage growth of new shoots so that wild animals can be lured to the area and be hunted (Savet, 1999; Daltry and Momberg, 2000; Baird, 2000; Bouaket, 1999)
- Clear vegetation to increase visibility of snakes or other wild animals, and bandits; and
- Suppress weeds and pests (e.g. in Myanmar, Sein et al., 1999)

It is also reported by FAO that forest fires are also caused by negligence during charcoal making, camp fires and smoking, burning trash, agriculture residues or pastures, or when children play with fire (FAO, 1991).

In Thailand from 1980 to mid-1990 the underlying causes of forest fires were due to deliberate or accidental human activities, especially by the rural people who live in or adjacent to forest (Samran and Akaaraka, 1997). They reported that:

- 26% forest fires were due to activities associated with the collection of non-timber forest products (NTFP)
- 18% through burning agricultural residues (especially in shifting agriculture)
- 15% by hunters
- 16% by carelessness.

In Brunei, arson and the use of fire on agriculture land and for land conversion are major causes of forest fire (Hassan and Manila, 1997). In Malaysia, negligence and agriculture activities are considered to be the most important causes of forest fire (Hassan and Manila, 1997). The disastrous forest fires in 1997/98 in Indonesia occurred mainly because of land clearance for large-scale plantations and timber estates (Dennis, 1999).

Many countries have also reported that communities use fire to destroy natural forests or plantations in revenge or for political reason. This may probably be due to conflicts arising from inequitable tenure arrangements.

In the mean time success stories over forest fire management can be obtained from sponsored projects. However, allocation of resources for forest fire management needs careful planning to ensure that poor are not over burdened by such arrangements. One important aspect concerning the success of community based fire management is that incentives for fire management must be considered in relation to community needs.

In addition to incentives for effective fire management, sanctions for unsound management is also necessary to impose community-enforced fines and penalties, rather than government legislations in discouraging people from breaking rules. It is stated that successful community involvement in fire management depends on the attachment of the community towards the forest resources which they rely day to day needs for their livelihood.

CBFiM is concerned with ensuring local peoples' access to and management of forest resources. The catalyst behind CBFiM approaches are indigenous land and / or use rights including the right to use fire as a management tool. The retention of traditional practices is strongly dependent on adequate level of empowerment of local populations to manage and use fire and forest resources.

CBFiM recognizes the human dimension of fire as well as the positive social and ecological benefits of smaller prescribed and managed fires. The application of CBFiM will demonstrate how villagers can manage fire for local daily subsistence needs without having detrimental effects of fire towards natural forests, in their neighborhoods. Many environmental problems, such as global warming, greenhouse effects, soil erosion, desertification, water resource degradation, loss of biodiversity and excessive flooding have been linked directly or indirectly with the decrease in forest cover. One cause of the rapid decrease in forest cover is the effects of various natural disasters. Among non-natural events, hunting and shifting cultivation are blamed for much of the loss in TNRP (Lynam A.J. et al., 2007).

Fire management is most effectively broken down into four discrete components:

- Prevention involves all measures that impede the out break of for reduce it severity and spread.
- Preparedness (pre-suppression) includes the actions and activities needed to ensure organizations are fully prepared for any fire suppression measures.
- **Response** (firefighting, also called suppression) refers to the control and extinguishing of unwanted fires. These actions attained the highest profile in most media coverage of fires, which can (and has) influence public and political opinions towards a firefighting-dominated response to fires
- Recovery refers to attempts to prevent recurrent of fires and further degradation of the forest in the short term and to re-establish the original (Karki, 2002).

5.0 Local Communities around the Nature Reserve area

5.1 Settlement history

There is a long history of settlement and four ethnic groups are now found settled in the vicinity of TNR, namely, Kayin, Dawei, Mon and Bamah. Kayin (Karen) and Dawei tribes seem to be forerunners in the known history of settlement for more than 200 years. Generally, Kayin ethnics settled in all parts of the area, but at the present, more concentrated in the middle part of TNR. Dawei tribes are occupied in the southern peripherals of the area. In contrast, migration of Mon people into the area is very recent. They started to set up their settlements in the northern fringes just 50 years ago and extended gradually southwards. The last settlers are noticeably Bahma individuals who moved to find better livelihoods and settled in the area mostly due to marriage ties with locals. Bahma migrants particularly settled in the villages of northern and middle parts of TNR. Accordingly, based on tribal dominance, TNR area can be recognized as Dawei ethnic vicinity of the southern part. Nowadays, Dawei are the most dominant ethnicity, representing about 40% of the people residing in the area.

Dawei people established Hnankye village last 200 years and Wunpo last 100 years ago. Yebon is supposed to be established by a few Kayin households last 100 years ago, but Dawei people accumulated in the village later on and gradually became dominant. Compared to other villages of the southern zone, Heinze is however rather recent which became settled in last 50 years. All inhabitants of Heinze, Hnankye and Wunpo at this instant are Dawei. Many members of the Dawei vicinity were born and raised in the area, enjoying their

second and third generation; even some are in their fourth generation (Min Thant Zin, 2009).

The middle part is dominated now by Kayin ethnics. Migyaunglaung village has been settled by Kayin families for two centuries. Kayin people also found their settlements in Zinba and Kyaukshut last 100 years ago. For the time being, Migyaunglaung still stands as pure Kayin village whereas other members of ethnic groups are, in due course, building up in Zinba and Kyaukshut. However, Kayin people of these villages are native settlers born and raised in their villages.

Mon villages of Yapu, Tharyarmon and Mayanchaung are in the northern part of the area. Mon people have been staying for less than 50 years. Particularly, Tharyarmon is a new satellite village of 8 years, which is resettled under the arrangement of Local Authorities. Originally, most of the people residing in this part are migrants from nearby Mon state and they move to the area for search of new farmlands. They settled the villages inside the reserved forests and gradually extended horticultural farms for their livelihood (Min Thant Zin, 2009).

The profiles of villages in the vicinity of TNR were obtained through the process of participatory approach carried out at each village during 2010 and 2011 by Reserve Management Team (RMT) with the assistance from Technical Advisory Team, WCS. The following map indicates the location of villages in TNR and accordingly most of the villages are situated along the Ye-Dawe road where as villages such as Migyaunglaung (old) and Zinba are quite far away from the highway but very close to Dawe River.

This study view forest fire management more holistically and aimed to be addressing the root causes of unwanted fires. The villages in TNR happened to be in remote locations where the response of efficient and suppression approaches from available advanced fire fighting facilities are severely hindered by access and response time.

Fire should not be completely excluded from the daily lives of people and the ecology of landscapes that they inhibit. The ways that communities use fire to cultivate crops and Non Wood Forest Products (NWFPs), to create forage and to management pests and diseases, except hunting, should still be allowed. These smaller and intentional fires appeared to be difficult to distinguish from uncontrolled or unwanted fires.



Land Use & Land Cover Status of TNR Area

Fig.1 Distribution of villages along Ye-Dawe Highway

6.0 Legal Provisions

The scientific management of Heinze / Kaleinaung Reserve since 1882 was as follows: the Kaleinaung reserve was duly constituted from 1885 whereas the Heinze reserve was constituted in 1902 by the British. Since then the general fire protection of these forest was enforced until 1913 when the protection of natural forests was abandoned (Smith, 1927). As a result of the various research developments and the global economic depression, fire protection in the natural forests of Myanmar was totally stopped from 1930 onwards; and protection has been carried out only in plantations up till now.

Protection of Forest Reserves and Protected Public Forest from fire under the jurisdiction of Forest Department is the promulgation of Forest Act, article 2, 27, 33(a), 50 (a) and Forest Rule 8 of 1902. The responsibilities of the public in relation to the protection of reserved forest from fire are reasonably complete as prescribed in the Forest Department Circular No. 2 & 25 of 1903 (amended by Circular No.37 of 1903).

The Forest Department Circular No.2 of 1903 (as amended by Circular No. 90 of 1910) contains the instructions for fire control operations in and around reserved forests. The responsibilities of government staff (other than forest department

staff) and of the public in regard to the protection of reserved forests from forest are laid down in the Forest Department Circular No.25 of 1903: however, with the promulgation of Forest Law (1992) it was not been followed any more.

In Chapter XII of existing Forest Law (1992), section 40, the following offences and penalties will be enforced for those whoever commits the following act shall, on conviction, be punished with the fine which may extend to K 5, 000 or with imprisonment for a term which may extend to 6 months or both:

"(f) Kindling, keeping or carrying and fire or leaving any fire burning which may set fire to the forest in reserved forests".

The "Rules for Reserved Forests" according to the Forest Manual, 1902, lately amended in 1941 and published in 1961, contain the prohibition of setting fires between 15 January and 15 June, and the necessity of obtaining written permission. And the regulation which imposes on all persons living in contiguous to the reserve within two miles of the reserved forest is also not observed any more. The regulation is concerned with those who are employed by the government or who receive emoluments from Government, have duty to furnish information regarding the occurrence of fires and assisting in extinguishing a fire within the reserve or preventing a fire from spreading to the reserve from outside. The same responsibility is also imposed on all persons exercising a right in a reserve or permitted to practice *taungya* cultivation there in.

Also, according to the Forest Department Circular No.2 of 1903 as amended by Circular No.90 of 1910, it was described on how to construct fire line, fire trace and safety strip as a protective belt on the border of forest reserves. The width of the fire line will not be less than 5 feet and on this line no fire shall, in any circumstances be allowed. The underlying reason of constructing fire lines is to serve as an automatic check on ground fires, as an inspection path and also to define the gazetted boundary of the forest.

The width of the fire trace may vary according to the conditions of the vegetation: on this area all undergrowth shall be cut and piled up for burning on the outside limit of the fire trace. The felling of trees on this area is at the discretion of the Conservator (currently Director) of forest department.

Also, it was mentioned that the width of safety strip varies from 300 to 500 feet according to the conditions of the forest. If funds are available these safety strips should be constructed.

7. Forest Fire Research

7.1 J.G. Goldarmmer (1986) during his consultancy for Fire Management had suggested based on his 'Forest Fire Management Studies' that the long term objectives of the future fire research programme must be designed according to the actual and specific problems which varies from type of forests in Burma (Myanmar). He suggested that prioritization should be given to the following:

- The role and influence of fire on teak-bearing forests
- Fuel management
- Fire behavior
- Erosion control
- Forest fire survey and evaluation.

He also made recommendations that absolute priority should be given to provision of funds for the Forest Research Institute, grant a relevant forest fire research training, concentrate on priority research subjects and lastly, cooperate with forest fire experts, especially on the regional level.

7.2 Also, M.J.D.Hancock (1988) during his consultancy on Forest Fire Management for the pilot demonstration area of 'Pilot Watershed Management for Kinda Dam' had emphasized that research studies on forest fire should be carried out in cooperation with the Forest Research Institute as this kind of

research is still in active at the present. He stated that the line of research in which special attention should be given to:

- Fuel management
- Fire behavior
- Erosion control, and
- The role and influence of fire on teak bearing forests.

7.3 Research Study on Indigenous Method of *Taungya* burning at Migyaunglaung Village

Owner: U Thar Soe

Date Burned: 24-3-2010

Time started: 17:00 hrs:

Time completed: 17:20 hrs

Weather Condition: 17:00 hrs: 31.5 ^oC: Humidity 64% at start time; cloudy weather without rain. Wind direction from south west; wind speed: Modified Beaufort scale Wind Class number 2: (1.5 to 3 m/sec: trees of pole size in the open sway gently; wind felt distinctly on face). According to Gangawtaung weather station data the last rainfall occurred on 17-3-2011 with 10.5 mm.

7.3.1 Preparation prior to burning

During the morning prior to burning fuel load was determined by weighing bamboos and small trees at 3m x 3m plots.

Plot No.	Weight (kg)	Bamboo / Small trees
Plot 1	23	Small bamboo culms
Plot 2	20	Small bamboo culms
Plot 3	68	Bamboo clump
Plot 4	93	Bamboo clump
Average	51 kg	
Average Plot 5	51 kg 59	Small trees
Average Plot 5 Plot 6	51 kg 59 32	Small trees Small trees
Average Plot 5 Plot 6 Plot 7	51 kg 59 32 50	Small trees Small trees Small trees

Average 47 kg



Locating 3m x 3m plot

Measuring weight of fuel (bamboo)

The plot area is mostly consisting of bamboo brake mixed with small trees. Ninety percent is made up of bamboos where as the rest composed of small trees. The fuel load is estimated to be 54 metric tons per hectare.

7.3.2 Fire line construction

Outer as well as inner fire lines were constructed. Inner fire line was constructed as 1 m width whereas outer fire line was constructed at a spacing of 2 m encompassing a plot of 30m x 30 inside the *taungya* plot. The plot is situated almost on the flat terrain at an elevation of 122 ft. The eastern side is bounded by fire line of 2m while on the north eastern side the cart-tract serves as fire break. The other sides of the *taungya* plot were encircled by 2m firebreaks.



Inner fire line (within 30 m x 30 m)



Checking outer fire line width

7.3.3 Final checklist before ignition

1. The owner already informed the Village Administrator for burning permit as well as neighbors.

2. The current weather condition was determined by experience with special care for wind speed. By experience they lit around at 17:00 hrs as the wind was quite calm and with very low risk of spot fire and spread.



Preparing bamboo fire torch



Initiate burning with bamboo torch

3. Afterwards, the team was organized for fire ignition as well as fire fighters in case of fire spotting (jumping).

4. Mostly men organized fire setting and women participated for suppressing the escaped fire and fire spread.

5. For tools and equipment the normal practice is to use machetes (*dah*) for cutting dry bamboos and split for use as fire torch to initiate burning while for suppression, they normally use tree branches.

6. As the area is quite small (1.5 acre and consists of bamboos) the supply of water is not considered in this case. For mopping up fire the normal practice is to use branches.





Grid ignition technique

Preparing to mop up

- 7. No fire fighting tools were available.
- 8. No first aid available.

7.3.4 Conducting the planned burn

The manner in which the fire is lit will dramatically affect the complete burn of *taungya* or not. Ideally, the fire should be slow burning and of low intensity to burn within the safe boundaries without spread to adjacent plots or orchards. No test fires were made as they are quite confident with igniting fires for ages. The technique adopted was a grid ignition technique in which fires were lit in a grid at a predetermined spacing. The spacing adopted was about 2 meters. The spacing of fires is dependent on factors such as fuel loads, wind speed, humidity and air temperature. With this burning technique, the aim is to complete the burn within 30 minutes of initial igniting. The spacing of the fires depends on the objective of the mosaic (arrangement of fuel), the fuel types and the dryness of the fuel.

The actual burn was conducted by the owner and experienced persons with a detailed knowledge of the fire behavior who is competent enough to consider topography, fuel and weather conditions. By experience they selected the late afternoon when the temperature is low, humidity is high and wind speed is low such that the fires will be safe to proceed with.



Observe the flame height and wind direction



Cart track as fire line and fire in progress

Normally they try to avoid mid-afternoon where the risk of hazard is quite high, particularly during 12:00 hrs and 14:30 hrs. After setting fire the next step was keeping the eye on the progression of the fire and to ensure that there were sufficient members to monitor for mopping up the fire to prevent spot fires and escapes. Altogether the team consists of 9 men and 4 women with a total of 13 persons.



Mopping up after the burn



Mop up team

The team waited for the time the area was completely burned down and mop up team had patrolled around the parameter, to determine if fire had escaped. Care had been taken to watch for sudden wind change during the progression of fire. After the burn the parameters along the outer fire lines and inner fire lines were inspected whether there were any fire escapes or not: it was clear that though the outer fire line is just 2 meters wide, it was sufficient to withhold the spread and spot fires. However, within the experimental trial of inner plot boundary of 30 m x 30 m, the fire jumped in some places where the width of the fire line was far below 2.0 m.

As the fuel load was not quite dense and the moisture content of the fuel appeared to be a little bit high, due to unexpected rain occurred a few days ago with the extent of 16 mm on 16-3-2011 and 10.5 mm on 17-3-2011, the plot was not completely burned down.



Fire jumping from one of inner fire line



Inner fire line quite effective

At least 90% of the area was burned and the remaining ones were bamboo clumps and some small woody stems which need re-burning (*Kyunkwe*) after a few days time. The burning process can be taken as successful as the actual burn went smoothly and trouble free that took 20 minutes against the expected time of 30 minutes as planned. The fire fighting team seems to be quite competent with their specific jobs and follows traditional practice and particularly, due to the 'construction of firebreaks', *which they seldom applied in the past*, is the key factor for this successful burning.

In future this kind of practice should be properly planned, informed concerned bodies like Village Administrator, TNRP, take proper records with supporting documents, for burning taungya, particularly for Community Forestry programs initiated by Reserve Management Team (RMT). In order to find out whether the

fire weather was favorable for burning for the above case, the Burning Index Alignment Chart (Example from Zinbabwe referred by Handbook on Forest Fire Control, Heikkili, 2007) was applied using dry bulb temperature and relative humidity). According to the alignment chart, the present condition falls under 'green category' which indicates the situation is favorable for safe burning. The experienced gained from this experiment proved that in order to find out the risk of fire danger priority to burning; weather information such as temperature and humidity can be assessed by using digital temperature/humidity meter and applying the alignment chart for the determination of 'Burning Index.'

8. Fire Weather Data

Either in large fires or in prescribed fires it is hard to manage fire suppression activities. This is because adequate information is needed therefore on fuel type, fuel condition, terrain data (slope, aspect, elevation), fire weather data (wind, temperature, etc), other vegetation data (canopy cover, stand height, crown base height, etc.) condition and position of fire fighting personnel and equipment, natural barriers, water resources and other information in relation to fire.

Fire Environment is more or less related to the following factors

- Fuel type, description
- Fuel condition, moisture content, humidity

• Weather- wind, temperature, etc

8.1 Wildfire Behavior

A small fuel load will cause a fire to burn and spread slowly, with a low intensity. If there is a lot of fuel, the fire will burn more intensely, causing it to spread faster. The faster it heats up the material around it, the faster those materials can ignite. The dryness of the fuel can also affect the behavior of the fire. When the fuel is very dry, it is consumed much faster and creates a fire that is much more difficult to contain.

The basic fuel characteristics that decide how it affects a fire are:

- Size and shape
- Arrangement
- Moisture content

Small fuel materials, also called flashy fuels such as dry grass, pine needles, dry leaves, twigs and other dead brush, burn faster than large logs or stumps. But in wildfire, where most of the fuel is made up of the same sort of material, the main variable in ignition time is the ratio of the total fuel surface area to its volume. Since a twig's surface area is much larger than its volume, it ignites quickly. By comparison, a tree's surface area is smaller than its volume, so it needs more time to heat up before it ignites.

As the fire progresses, it dries out the material just beyond it - heat and smoke approaching potential fuel causes the fuel moisture to evaporate. Fuels that are somewhat spaced out will also dry out faster than fuels that are packed tightly together, because more oxygen is available to the thinned out fuel. More tightlypacked fuels retain more moisture, which absorbs the fire's heat.

Weather plays a major role in birth, growth and death of a wildfire. Drought leads to extremely favorable conditions for wildfires, and winds aid wildfire progressweather can spur the fire to move faster and engulf more land. It can also make the job of fighting the fire even more difficult.

There are three weather ingredients that can affect wildfires:

- Temperature
- Wind
- Moisture

Temperature affects the sparking of wildfires, because heat is one of the three pillars of the fire triangle.

The sticks, trees and underbrush on the ground receive radiant heat from the sun, which heats and dries potential fuels. Warmer temperature allows for fuels to ignite and burn faster, adding to the rate at which a wildfire spreads. For this



Fire Behavior Triangle

reason, wildfires tend to rage in the afternoon, when temperatures are at the hottest (see Temperature / Humidity chart average hourly data for March 1-7 at Pipeline Centre).

Wind probably has the biggest impact on wildfire's behavior. It is also the most unpredictable factor. Wind supply the fire with additional oxygen, further dry potential fuel and push the fire across the land at a faster rate. It is quite certain that the stronger the wind blows the faster the fire spreads. Also, the fire generates winds of its own that are as many as 10 times faster than the ambient

wind. It can even throw ambers into the air and create additional fires as spot fires that can enhance fire spreading. Wind can also change the direction of the fire, and gusts can raise the fire into the trees, creating a crown fires.

You can observe from the wind speed chart that wind speed starts accelerating around noon and at its maximum at 3 p.m. and declining after 5p.m. which indicates that it is very difficult to suppress the fire during the afternoon hours from 1p.m.to 4 p.m.

Also in terms of wind direction the normal wind starts from dawn to noon in north west direction and then changes the direction to south west starting from noon till 6:00 p.m. and then change to south east up till dusk as observed from weather data received from Pipe Line Center (TEPM) for March 2011 from their automatic weather station (see the following figures 2-10).

While wind can help the fire to spread, moisture works against the fire. Moisture in the form of humidity and precipitation can slow the fire down and reduces its intensity. Potential fuels can be hard to ignite if they have high levels of moisture, because the moisture absorbs the fire's heat. When the humidity is low, meaning that there is a low amount of water vapor in the air, wildfires are more likely to start. The higher the humidity, the less likely the fuel is to dry and ignite. Since soil moisture can lower the chances of a wildfire igniting, precipitation has a direct impact on fire prevention. When the air becomes saturated with moisture, it releases the moisture in the form of rain. Rain and other precipitation (snow, etc.) raise the amount of moisture in fuels, which suppresses any potential wildfires from breaking out.

The following charts portrays the fact that how rainfall can have affect on ambient air temperature and humidity due to precipitation. On 12-4-2011 the weather was a little cloudy while it rained after 6:00 pm. The rainfall record was 45.5 mm. This rainfall had an impact on temperature and humidity which had significant impact on wildfire risk. On the 12th April the initial moisture content was low when compared to the 13th April data, which indicated the low chances of wildfire on the 13th. On the 12th the temperature started rising at 10 a.m. whereas due to the rainfall previous day the temperature ascended quite late at 1:00 p.m. indicating that the risk of fire incidence was low when compared to the 12th situation which was definitely due to high humidity derived from rain..


Fig.2. Temperature / Humidity Chart on 12/4/11 before rain



Fig.3.Temperature/ Humidity Chart after rainfall of 45mm.



Fig.4.. Weather station at PLC



Fig.5. Wind speed and wind direction devices



Fig.6. Automatic weather station at PLC



Fig.7. A portable digital Temperature / Humidity meter

TNRP has a rainfall station and a portable temperature / humidity meter at Gangawtaung Office. The portable digital Temperature / Humidity meter is readily available in Yangon which is quite reliable when compared to data received from the weather station at Pipeline Centre of TEPM.



Rainfall Recording Station TNRP

Figure 8. provides average Temperature / Humidity curve for 7days for March 2011(source: PLC).

Fig. 9 and 10 provides wind speed chart for 7 consecutive as well as wind direction chart for 7 consecutive days in March 2011 (source: PLC).



Fig. 8. Average Temperature / Humidity curve for 7days for March 2011(Source: PLC)



Fig. 9.. Wind speed chart for 7 consecutive days in March 2011 (Source: PLC)



Fig. 10. Wind direction chart for 7 consecutive days in March 2011 (Source:PLC)

Table 1. Weather Data received from Pipeline Center (TEPM) on hourly basis by day (sample data format)

Date	Time	DEW POINT	Wind Speed	Rel. Humidity	Barometric press	QNH	Wind Direction	Temperature
01.04.2011	00:00	19.49	1.25	87.20	1011.75	1012.01	80.46	21.83
01.04.2011	01:00	19.27	1.12	87.20	1011.07	1011.33	77.88	21.61
01.04.2011	02:00	19.12	1.47	87.20	1010.53	1010.80	55.70	21.45
01.04.2011	03:00	18.87	2.42	87.20	1010.32	1010.58	47.95	21.19
01.04.2011	04:00	18.87	2.18	87.20	1010.62	1010.88	47.72	21.19
01.04.2011	05:00	18.69	1.53	87.20	1011.15	1011.41	46.95	21.01
01.04.2011	06:00	18.45	2.13	87.20	1011.82	1012.08	55.82	20.75
01.04.2011	07:00	19.77	2.53	84.55	1012.75	1013.01	49.42	22.64
01.04.2011	08:00	19.66	2.23	70.10	1013.45	1013.71	62.12	25.71
01.04.2011	09:00	17.79	1.95	52.63	1013.65	1013.91	41.95	28.56
01.04.2011	10:00	16.97	2.15	43.57	1013.17	1013.43	34.45	30.92
01.04.2011	11:00	17.09	1.92	40.25	1012.33	1012.60	4.14	32.45
01.04.2011	12:00	19.00	3.85	44.53	1011.08	1011.35	270.57	32.82
01.04.2011	13:00	19.56	4.70	49.37	1010.05	1010.31	265.29	31.62
01.04.2011	14:00	20.21	4.82	52.85	1009.18	1009.45	272.69	31.12
01.04.2011	15:00	20.63	4.45	55.50	1008.63	1008.90	268.82	30.74
01.04.2011	16:00	21.55	4.45	62.30	1008.60	1008.86	259.29	29.71
01.04.2011	17:00	21.76	3.25	66.78	1008.88	1009.15	258.01	28.74
01.04.2011	18:00	22.78	1.87	77.33	1009.75	1010.01	233.71	27.29
01.04.2011	19:00	22.83	1.52	82.00	1010.65	1010.91	179.89	26.34
01.04.2011	20:00	22.68	1.08	85.23	1011.62	1011.88	189.92	25.53
01.04.2011	21:00	22.33	0.20	86.58	1012.30	1012.56	339.60	24.90
01.04.2011	22:00	21.91	0.67	87.25	1012.63	1012.90	214.60	24.33
01.04.2011	23:00	21.48	0.00	87.30	1012.38	1012.65	0.00	23.88
02.04.2011	00:00	21.18	0.00	87.30	1011.53	1011.80	0.00	23.57
02.04.2011	01:00	20.89	1.47	87.25	1010.75	1011.01	57.92	23.28
02.04.2011	02:00	20.50	0.88	87.20	1010.15	1010.41	59.74	22.88
02.04.2011	03:00	20.25	1.33	87.20	1009.72	1009.98	56.94	22.62
02.04.2011	04:00	20.02	0.83	87.20	1009.73	1010.00	54.62	22.39

Weather data can also be obtained from internet for Kanbauk Area, Taninthayi Region on hourly data as well as weather forecast on hourly basis for 3

consecutive days ahead, free of charge. Information includes temperature, precipitation, wind and humidity which are essential for the determination of **'forest fire danger index**" (see fig. 11).Source: www.accuweather.com .

	,	uweau iei .	com/en/n	IIII/Kandau	IK/ 144283	ia/nouny-v	weau ier-io	recasty 14
low W	eekend	15-	Day	Month				
- 5 of 15 days	All 15 da	ys						Next 5 :
Tonight		Mon		Tue	١	Wed		'hu
Feb 19		Feb 20		Feb 21	F	Feb 22	F	eb 23
				8				
mostly cloud	y plent	y of sunshi	ne clou	ds and sun	S	unny	bright	sunshine
19°	3	2 °	3	7 °, , , , , , , , , , , , , , , , , , ,	33	0	34	0, 170
		LO 18'	J2	more	55	nore		LO 17°
Daily	Hourly	Mornin	g Af	ternoon	Evenin	g Ov	vernight	
	Sun 12am	1 am	2am	3am	4am	5am	6am	7am
	74		0	0	742	P.	-	÷
Forecast	T- storms	T- storms	Cloudy	Cloudy	T- storms	Mostly Cloudy	Mostly Cloudy	Mostly Cloudy
Temp (°C)	23°	25°	24°	24°	23°	23°	22°	22°
RealFeel®	23°	26°	26°	25°	24°	23°	22°	25°
Precipitation		50 %			51%		33	7%
Wind (kph)	2 NW	3 NW	3 N	3 NNE	3 NE	3 NE	3 NE	3 NE
Humidity	79%	83%	83%	83%	82%	82%	81%	96%
UV Index	0	0	0	0	0	0	0	0
Cloud Cover	97%	59%	65%	72%	77%	83%	88%	78%
Dew Point	19°	22°	21°	21°	20°	19°	19°	22°

Fig. 11. Weather data received from <u>www.accuweather.com</u> for weather forecast.

8.2 Forest Fire Danger Index



Fig 12. Forest Fire Danger Meter Mk5

Fire danger indices are used in many parts of the world to integrate meteorological and fuel information into a single or small number of measures. These measures can then be applied to regions for the issuing of warnings, or more locally to estimate the suppression difficulty of a single fire or fire complex. Forest Fire Danger Meter (Mk5) was developed by CSIRO, Australia in 1992 for

predicting forest fire danger. The principle of this meter is based on air temperature, relative humidity, wind speed, drought factor and rainfall pattern. As an exemplary, one Australian McArthur Forest Fire Danger meter was provided to Forest Research Institute by Goldammer during his fire management consultancy in Myanmar (Goldammer, 1986).

A more simplified version of '**Fire Weather Index'** is the burning index developed in Zinbabwe, which indicates the expected fire behavior situation of the forest fuels. The fire weather index is calculated on the basis of relative humidity, wind speed, rainfall and temperature.



Example from Zimbabwe- Fire Hazard Index (0-39=green, 39-59=orange over 59= red, do not burn)

Fig.13. Burning Index Alignment Chart (Zinbabwe)



Add wind factor of:	25.0
Fire Hazard Index:	40.2

Source: Handbook on Forest Fire Control: V.H.Timo et.al., (1993)

As wind speed and rainfall has influenced over humidity, a more 'Simplified Fire Danger Index' has been modified for TNR based on temperature and humidity (in relation to rainfall and wind speed) for the whole year data of 2011received from PLC (TEPM).

Burning Index:	< 22	Low
	22-42	Moderate
	42-53	High
	>53	Extreme



Fig.14. Fire Danger index alignment chart (TNR)



Fig.15. Fire Danger Index signboard showing different situations

Temperature and relative humidity are taken at 3 pm where the temperature is generally at its peak as received from weather data at PLC (TEPM). It is learnt that the weather information is more or less similar at same latitudes; as Zinbabwe and TNR are within the same latitude of approximately 15[°] North

(TNR) and 15^{0} S.(ZBB) The weather data as acquired from ACCUWEATHER on 11-2 2012 is as follows:

Table 2. Weather data of Zinbabwe and Kanbauk

Date 11-2-2012												
	Tempe	erature	Hum	nidity								
Hour	Zinbawe	Kanbauk	Zinbawe	Kanbauk								
1	23	23	82	78								
2	22	24	84	77								
3	22	24	88	75								
4	22	22	91	80								
5	21	22	88	79								
6	22	22	91	77								
7	23	21	88	75								
8	23	23	81	86								
9	26	25	56	76								
10	25	26	70	68								
11	28	27	58	62								
12	29	27	51	58								
13	30	28	61	53								
14	30	30	56	66								
15	31	30	52	60								
16	31	30	50	57								
17	32	30	47	54								

18	31	31	49	50
19	29	29	53	54
20	28	28	56	61
21	27	26	59	65
22	26	25	65	68
23	24	24	73	72
24	23	24	78	73
Average	26.17	25.88	67.79	67.67

ost Visited 📔 Ge	tting Started	🔝 Latest	Headlines 💽	VouTube H	nome			
Kanbauk Hourly	Weather -	AccuWea	. +					
Daily	Hourly	Mornin	g Aft	ernoon	Evenin	g Ov	vernight	
	Sat 12am	1am	2am	3am	4am	5am	6am	7am
	9	9	9	9	9	9	5	6
Forecast	Mostly Clear	Partly Sunny						
Temp (°C)	23°	24°	24°	22°	22°	22°	21°	23°
RealFeel®	23°	25°	24°	22°	21°	21°	20°	25°
Precipitation		22%			8 %		27	9/0
Wind (kph)	2 NW	3 NNW	3 NNW	3 N	2 NNE	2 NNE	2 NNE	5 ENE
Humidity	78%	77%	75%	80%	79%	77%	75%	86%
UV Index	0	0	0	0	0	0	0	0
Cloud Cover	25%	28%	22%	24%	25%	25%	25%	45%
Dew Point 2ວ ປ	19°	20°	19°	19°	18°	17°	17°	21°
	•	-	-					
				-	•		-	
20 C	12am	1am	2am	3am	4am	5am	6am	7am

Fig16. Weather data Kanbauk (11-2-2012) as acquired from Accuweather

The weather data of Zinbabawe on the same date (12-2-2012) is provided below.

> - C	X 🏠	5 http:	//www.accuv	weather.com	i/en/zw/zimba	bwe/808238	/hourly-weat	her-forecas
last Visitad 📑 C	atting Charled		Handlings F	VouTubo k			, , ,	
	etting Started		neaulines 🗳		IUIIIE			
	ny weather	- Accuwe.	. 7					
🐴 19.9 mr	n of rain	on the w	ау					
Daily	Hourly	Mornin	g Af	ternoon	Evenin	g O	vernight	
	Sat 12am	1am	2am	3am	4am	5am	6am	7am
Ferenat	6	۲	6	۲	6	9	9	۲
Forecast	Clear	Mostly Clear	Clear	Mostly Clear	Clear	Mostly Clear	Mostly Sunny	Mostly Sunny
Temp (°C)	23°	22°	22°	22°	21°	22°	23°	23°
RealFeel®	23°	23°	23°	23°	22°	25°	24°	25°
Precipitation		0%			0%		0	%
Wind (kph)	5 NNE	3 N	3 N	2 N	2 NNW	0	2 NNW	3 NNW
Humidity	82%	84%	88%	91%	88%	91%	88%	81%
UV Index	0	0	0	0	0	0	0	1
Cloud Cover	0%	18%	0%	18%	0%	29%	16%	11%
Dew Point	20°	20°	20°	20°	19°	21°	21°	20°
20 U								
20 C								
	12am	1am	2am	3am	4am	5am	6am	7am

Fig.17. Weather data Zinbabwe (11-2-2012) as acquired from Accuweathe

9. Fire Information for Resource Management System (FIRMS)

Fire Information for Resource Management System (FIRMS) integrates Remote Sensing and Geographic Information System (GIS) technologies for delivering global MODIS (Moderate Resolution Imaging Spectroradiometer) instrument on board NASA's Aqua and Terra satellites, using thermal band for detecting hotspot fires.

FIRMS is primarily aimed at supporting natural resource managers, researchers, planners and policy makers by helping them understand when and where fires occur and delivering the fire information in near real-time and in easy-to-use formats.

Each hotspot / active fire location represents the centre of a 1km pixel (approximately) flagged as containing one or more actively burning hotspots / fires within this pixel. The location is the centre point of the pixel and no necessarily the coordinates of the actual fire.

MODIS routinely detects both flaming and smoldering fires 1000 m² in size and in favorable condition it can detect smaller flaming fires of 50m².

According to Forest Fire Atlas (Source: National Fire Agency, Singapore), reported in 2008, the characteristics of hotspots in Myanmar for 10 day observation of forest fire cases were as follows:

Year: 2008

Area (acres)

State/Division	1Jan	11 Jan	21 Jan	31 Jan	10 Feb	20 Feb	1 Mar	11 Mar
	to 10	to 20	to	to	to	to	to	to
	Jan	Jan	30 Jan	9 Feb	19 Feb	29 Feb	10 Mar	20 Mar
Ayeyarwaddy	0.44	967	227	0	3178	3405	4994	4767
Bago	0.29	1064	1777	3698	7890	8629	10355	10355
Chin	0.43	68	0	0	1148	2755	8493	17675
Kachin	0.55	1137	0	2275	3981	5687	7962	10805
Kayah	0.15	224	150	75	524	1047	1272	2170
Kayin	2.67	1359	1359	388	3300	2330	4271	6600
Magway	0.29	856	1664	3708	15975	17116	22536	31093
Mandalay	0.14	1190	1666	2619	2619	3571	5952	7380
Mon	0.00	0	0	76	0	76	76	305

59

Rakhine	1.15	246	0	246	492	5162	3933	4671
Sagaing	0.15	2285	0	3014	1808	6631	10248	25318
Shan	0.00	43714	17158	35831	88583	124414	169203	35335
Taninthayi	0.00	232	927	232	0	696	1391	2550
Yangon	0.00	65	131	261	261	522	261	326

Year: 2008

Area (acres)

State/	21 Mar	31 Mar	10 Apr	20 Apr	30 Apr	10 May	20 May	30 May
Division	to 30	to	to	to	to	to	to 29	to
	Mar	9 Apr	19 Apr	29 Apr	9 May	19 May	Мау	9 Jun
Ayeyarwaddy	1135	1362	4313	1816	227	0	0	
Bago	10109	8876	11835	3205	0	0	0	0
Chin	16298	19053	16069	18135	459	0	0	0
Kachin	10805	79618	97247	75068	1137	2275	0	0
Kayah	1870	1421	1721	0	0	0	0	0
Kayin	7765	5047	7377	971	0	0	0	0
Magway	25103	22536	18542	15975	285	0	285	0
Mandalay	6428	5475	2857	714	0	0	0	0
Mon	152	76	76	0	0	0	0	0
Rakhine	3442	9342	9342	11308	0	0	246	0
State/	21 Mar	31 Mar	10 Apr	20 Apr	30 Apr	10 May	20 May	30 May
Division	to 30	to	to	to	to	to	to 29	to
	Mar	9 Apr	19 Apr	29 Apr	9 May	19 May	Мау	9 Jun
Sagaing	47019	83188	74146	89246	1808	1206	1808	603
Shan	383195	333429	306556	129390	0	0	0	0
Taninthayi	4405	4869	4869	464	0	0	0	0

Yangon	0	131	131	65	0	0	0	0
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Fig.18. Forest Fire in Myanmar (2008)

According to fig.18, it is quite evident that during 2008 fire season the forest fire incidence in Tanintharyi division was quite negligible compared to other Divisions and States.

Fig.19. provides MODIS Wildfire Map for 7/1/2012 from institute of Industrial Science.U-Tokyo and fig 20., indicates attribute data showing locations in latitude and longitude, and acquired date and time.



Fig.19. MODIS map showing hot-spot data in 7-1-2012



Fig.20. MODIS hot spot with attribute data showing locations and transferred on

to 1:50000 map



Fig.21. Forest fire incidence in TNR 2010 and 2010 (hotspots)

A detailed study of forest fire hotspots in 2010 and 2011in TNR area indicated that the hotspots data, when overlaid on forest land use types clearly depicted the high forest fire incidence in the deciduous / semi-evergreen type when compared to evergreen types. The low forest fire incidence rate of 2011 when compared to 2010 (a drought year) may probably due to early rainfall in 2011 (January to April) when compared to 2010 rainfall data received from PLC.

Rainfall (mm)

MONTH	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
JANUARY	0	0	0	0	0	0	0	0	0	20	29
FEBRUARY	0	0	0	0	0	0	0	51	11	0	0
MARCH	81	0	80	0	8	32	0	7	32	0	40
APRIL	0	21	14	0	28	236	70	180	182	5	119
MAY	823	890	851	503	595	719	640	984	304	246	409
JUNE	1231	802	850	1078	1322	941	628	891	1112	572	1136
.IUI Y	1088	1438	1200	826	1632	1944	1168	928	1527	601	1115
AUGUST	1864	1469	1516	1815	1037	1697	1271	1039	852	1301	1363
SEPTEMBER	363	1110	742	517	876	548	785	1038	1022	469	1177
OCTOBER	91	111	122	32	292	374	598	252	296	0	233
NOVEMBER	40	70	0	0	110	0	0	70	10	0	0
DECEMBER	0	42	0	0	9	0	0	0	0	24	0
Total	5580	5953	5374	4771	5910	6491	5158	5439	5347	3239	5620

Fig.22. Rainfall data from 2001 to 2011 at Kanbauk (PLC)

It can be observed that rainfall in 2010 is almost 50% of rainfall recorded for previous years and can be assumed as a drought year in TNR area. The incident rate of hotspots indicated that in March 2010, there were 16 hotspot locations of forest fire incidence as recorded from MODIS, whereas during March 2011 the incident rate had reduced to 1 hotspot (probably due to early rainfall in 2011)..

It can also be observed from the hotspot data overlaid to land use type maps that the forest fire incidences mostly occurred in the vicinity of Village Use Zone and quite a few in the Core Zone where the vegetation is made up of closed type of evergreen forests with the risk of forest fire quite low, compared to open type forests of deciduous type of forest associated with bamboo which are prone to high forest fire risk, particularly below the elevation of 500 feet.



Fig.23. Rainfall data 2001-2011 Kanbauk



Fig.24.The incidence of forest fire at "Phwa Shinma hill" near Kaleinaung Junction on 5/3/2010 as seen from MODIS hotspot map



Fig.25. On ground fire which lasted for 7 consecutive days recorded by TNR

The hotspot data provided by MODIS when compared with on ground data, it really proved that the information is quite reliable as seen from the incidence of fire at "Phwa Shinma hill" as recorded in fig15 and 16.

It can also be observed from the hot spot data of 2011 April that in the northern part of TNRP a few hot spots occurred in the core zone most probably along the Kin stream drainage. These may probably be due to taungya burning activities carried out by Mon ceased-fire settlers inside TNR.



Fig.26. Forest Hot-spot data on 25/26-12-2011

over laid on to contour map

The hot-spot laid over a contour map gave indication that the taungya burning in 25-12-2011 and 26-12-2011 occurred in a relatively flat area (approx 200'-300' elevation) inside TNR boundary (green) and quite far away from Ye-Dawe road (red).





for April 2011


Fig.28. Google map showing village near TNR boundary at Mon area



Fig.29. Mon village inside TNR Core Zone along Kin stream flood-plain

Fig.28 and Fig. 29 indicated that Mon re-settled villages are situated in and around the boundaries of TNR as clearly depicted in Google Satellite Map.



Fig. 30.Contour-bund plantations inside TNR boundary at the Mon ceased-fire zone



Fig.31. Contour-bund plantations inside TNR boundary (double green line) overview It can also be observed from fig. 30 and fig. 31 that Mon re-settlers practiced advanced farming techniques such as "contour bunds' which can rarely been seen elsewhere in TNRP.



Fig.32. Forest Fire Map from MODIS (2012 January)



Fig. 33 Hot-spot locations inside TNR boundary in December 2011

Fig 32 and fig.33 (the above contour map) indicated that the fire hot-spots occurred in late December 2011 and early January are most likely from taungya burning activities from Nwe Kyar Aing village inside TNR boundary with relatively flat terrain.



Fig.34. Forest Fire incidence February 2012

Also from fig. 28, it can be observed that in February 2012 the forest fire hot spots were still active in the northern most area of TNR (around flat areas of Kin

stream valley which are areas not being given access for RMT for the time being due to security reasons) and comparatively quite a few elsewhere.

10. Stakeholders' Perception on Forest Fire

It has been stated that in Myanmar forest fires, referred to as wildfires locally, are mainly surface fires that can spread over a large area but do not turn into intensified burning. None the less it can destroy up to 10 tons of forest fuel in one hectare area. Consequently, every year 30 to 70 tons of top forest soil loss occurs (Anon, 2009).

The following are the various stakeholders interacted with 'Forest Fire' in TNRP:

- Local communities
- Private plantation owners
- Oil and Gas personnel
- Military Batallians

10.1 Local Communities'

Causes of forest fire were determined at villages along TNR using questionnaire survey and the results are as follows:



B= Camping (Hunters) C= Smoking D=Arson E= Shifting Cultivation F=Others

									(percentage scores)			
Category	HKE	YBN	KST	KHL	KLA	ТҮМ	M60	Average	RANK Causes			
Α	0	0	5	0	0	0	11	2	5	Lightning		
В	50	40	35	54	67	56	32	48	1	Hunters (Camping)		
С	5	0	20	25	13	11	21	14	3	Smoking		
D	5	40	5	0	13	11	11	12	4	Arson		
E	41	20	35	21	7	22	26	25	2	Shifting Cultivation		
F	0	0	0	0	0	0	0	0	6	Others		

N=128

10.1.1 Causes of Forest Fire In Taninthayi Nature Reserve as determined from the Forest Fire Management Workshop

A participatory approach was applied during the workshop at the Environmental Education Centre

(EEC) with the participation of communities in and around TNR and the following was the results

achieved from the workshop about the causes of forest fire in TNR.

Likely Sources

Smoking

Hunting

Camping

Shifting Cultivation

Candle Lighting

Illegal logging

Natural Causes

Group 1	SMK	HUN	САМ	SHC	CNL	ILG	NAC	Total	Rank
SMK		HUN	CAM	SHC	SMK	SMK	SMK	3	4
HUN			HUN	HUN	HUN	HUN	HUN	6	1
CAM				SHC	CAM	CAM	CAM	4	3
SHC					SHC	SHC	SHC	5	2
CNL						CNL	CNL	2	5
ILG							ILG	1	6
NAC									

PAIR-WISE RANKING APPROACH

Where: SMK= Smoking HUN=Hunting CAM=Camping SHC=Shifting Cultivation CNL= Candle Lighting ILG= Illegal logging NAC= Natural Causes

Source: Forest Fire Management Workshop TNRP (2012) based on the pairwise ranking approach.

Both approaches highlighted that hunting and shifting cultivation are the main causes of forest fire in TNR.



Fig. 35 Forest Fire Management Workshop at TNR (9-2-2012)

10.1.2 Results of questionnaire survey on use of fire as land preparation techniques

A questionnaire survey was performed at 4 villages where fire is used as land preparation techniques for taungya cultivation, viz., Migyaunglaung (old), Zinba, Yaphu and Mayanchaung villages.



Explanation: Crops are planted generally for only one year in taungya.



Explanation: Over 80% used fire as land preparation tool in TNR



Explanation: Migyaunglaung and Zinba villages practiced taungya plantation over 30 years (these two villages got Karen Area in 1926 to practice shifting cultivation according to Heinze / Kaleinaung Working Plan). These two villages have handover ancestral knowledge since then.



Explanation: Taungya cutting period varies from December as earliest and April as latest before the onset of rains.



Explanation: Fire lines were constructedf at every village .



Explanation: Back firing was not much practiced the southern part villages such as Migyaunglaung and Zinba villages. However, in Yaphu (new) and Mayanchaung villages they seldom practiced back firing.



Explanation: For incharge of taungya burning Village Administrator has being consulted or normally set by themselves (others); neither forest department nor TNRP are being informed.



Explanation: Before start burning the plot, most of the villagers consider temperature as well as humidity.



Explanation: In case of fire spread to other people's farms the dispute has been settled using traditional way in Yaphu and Mayanchaung villages while in Zinba and Migyaunglaung villages, they normally settled with the police.



Explanation: There has been quite a few arson cases in the TNR area



Explanation: Villages at the southern part of TNR are quite aware about the forest law while the villages in the northen part like Yaphu and Mayanchaung villages are not conversant with forest law.



Explanation: TNRP has made presentations on forest fire over 80% in MGL, Zinba and MYC while at YPU (N), comparatively it is quite low .



Explanation: There is no conflict betweem villagers and private plantation owners (rubber plantations) in the vicinity of TNR.



Explanation: The above figure depicts that there were few fire incidences during the last 10 years period in TNR.



Explanation: Forest fire incidences occurred in TNR were mostly of palm oil

plantations and rubber planatations with quite few in orchards and Community

Forestry plantations.

10.1.3 Other activities' concerning taungya plantation techniques as practiced by villages in TNR

Activities	MGL (Old)	ZBA	MYC	YPU (N)	Explanation
Taungya (acres)	1 to 3 ac	1-4 ac	2-3 ac	6 acres	
Fire line width	6 to 15'	5-12	6'-15'	10'	
Fire set time	14 to 19 hrs	13-18 hrs	14-18 hrs	14-20 hrs	
Persons use for burning	3 to 10 pers	1-10 pers	16-18 pers	4-10 pers	
Determination of wind direction, wind speed	LM/S/F	LM/S	LMSF	LM/T/L/S	LM:Leaf Movement, T:Trees,L:Lighter, S:Smoke
Taungya burning pattern	1PD:2-3/C	1PD	AD/1PD	1PD/AD	1DP:1 plot per day, AD: all plots per day
Prevention of fire spreading	FL/FW	FL	FL/FW	FL/FW	FL: Fire lines; FW; Fire watchman
Suppression method	C/B/W	B/C/NP/W	S/C/B	W/C/B	C: Community, B:Branches, W:water, NP: no plan

Table 3. Questionnaire responses from villagers practicing taungya

Explanation:

- Taungya acreages vary from 1-6 acres only.
- Fire line width varies from 6-15 feet
- Fire setting time starts as early as 13 hrs and the late hour takes place at 20

hours.

- Persons used for setting the fire varies from 1-18 persons with an average of about 10 persons
- Determination of wind is determined using movement of trees, leaf movement, flame from lighter and smoke
- Taungya burning pattern is carried out 1 day per plot or all plots within the day
- Prevention of fire spreading is normally practiced by creation of fire lines or by assigning fire watchmen.
- Fire suppression method applied is through community effort by beating up with branches. There are no proper plans set for this purpose

10.1.4. Results of Questionnaire survey on Forest Fire Knowledge among villages in the vicinity of TNR

	Villages (% score)							
Question	TYM	M60	KLA	KHL	KST	YBN	HKE	Average
Q1	33	61	60	42	35	100	41	53
Q2	38	44	7	25	25	80	50	38
Q3	56	32	67	54	35	40	50	48
Q4	89	89	100	96	90	100	91	94
Q5	78	78	67	79	75	100	86	80
Q6	67	67	87	63	60	80	45	67
Q7	22	17	40	50	55	60	59	43
Q8	67	61	80	63	40	80	73	66
Q9	89	83	80	79	75	100	68	82
Q10	67	56	60	71	75	60	55	63
Q11	22	28	33	29	5	20	9	21

Table.4. Question Survey for Assessment of Forest Fire Knowledge

Q12	67	37	27	21	40	20	32	35
Q13	89	83	93	96	85	100	95	92
Q14	100	89	87	58	50	100	86	81
Q15	100	94	80	88	85	100	73	89
Q16	22	39	33	25	30	80	23	36
Avg	63	60	63	59	54	76	59	62



Fig.36.Fire knowledge scores among 7 villages

Villages	TYM	M60	KLA	KHL	KST	YBN	HKE	Score	Rank
	(63)	(60)	(63)	(59)	(54)	(76)	(59)		
ТҮМ		ТҮМ	KLA	TYM	TYM	YBN	ТҮМ	4	3
(63)									
M60			KLA	M60	M60	YBN	M60	3	4
(60)			\searrow						
KLA				KLA	KLA	YBN	KLA	5	2
(63)									
KHL					KHE	YBN	HKE	1	6
(59)						\searrow			
KST						YBN	HKE	0	7
(54)									
YBN							YBN	6	1
(76)									
NKE								2	5
(59)									

Table 5.	Pair-wise comparison among villages in TNR on Forest Fire
Knowledge	

According to the paired comparison test among villages along TNR, Yebone has the best forest fire knowledge followed by Kaleinaung, Thayarmon, Mile 60, Hnankye, Kawhlaing and Kyaukshut, respectively.

10.2 Private Plantations

10.2.1 Rubber Plantations at Thet-Ke-Gwet and Ok-Tha-Yan Village

The extent of rubber plantations at Thet-Ke-Gwet and Okthayan consists of small private plantations of less than 10 acres, with the exception of one 500 acres

plantation, were established starting from 2010. In 2009 the then Divisional Peace and Development Council had allowed a corridor consisting of 1000 yards (3000 feet) on each side of Ye-Dawe highway for the establishment of rubber plantations in Taninthayi region.

The rubber plantation areas are situated inside TNR buffer zone area in Heinze / Kaleinaung reserve in the southern boundary of TNR. Taungya method had been used for the establishment of rubber plantations. Fire was used as tool for land preparation. All of the plantation owners had no practical experience for rubber plantation establishment. Taungya cutting period started during the period from December to March. As usual practice taungya burning period normally consists of March and April.

For in-charge of taungya burning, majority carried out by themselves while others informed the Village Authority. Persons involved in taungya burning consist of 10-50 persons depending on the extent of the plantation. Women also participate in the burning process. During the burning wind speed and wind direction are estimated using traditional methods using leaf movement, smoke and movement of trees. Temperature and humidity are also considered for deciding the time of burning and mostly set fire during the late evening after 6:00 p.m. when the wind is calm and the temperature is low. Before the burn fire lines are constructed with the width varying from 8-30 feet for majority of plantations. Nobody practiced controlled burning with and as a result no fire spread to plantations and forests nearby. In order to prevent from spot fires, fire lines and fire breaks are constructed wide enough to contain spot fires. So far there has been no experience of fire due to arson.

The majority has no contact with the Forest Department as well as TNRP for legal acquisition of land. Although the areas under rubber plantations are inside TNR boundary no contracts have been signed with TNR so far. Some get a chance to attend presentations made by TNR on CF. These private rubber plantations have no conflicts with the villagers. There was only 1 incidence of forest fire in Padaukkone village in 2008. In case of fire, normally the fire was suppressed by using branches with the assistance of neighbors and the community. In order to prevent fire, gongs are used as alert and alarm.



Fig.37. Fire lines at rubber plantations



Fig.38 Fire lines on steep slopes at rubber plantation

10.2.2 Private plantations of commercial scale close to TNR boundary

10.2.2.1 Yaung Ni OO Rubber Plantation

The area consists of 300 acres in the western side of Ye-Dawe road at the southern part of TNR. The plantation area is quite close to TNR boundary. So far there is no intrusion of forest fire in Yaung Ni Oo rubber plantation. Fire lines construction started in January 2012 and the width of the fire line was 40 feet. If forest fire encroaches, it was suppressed by beating up with branches. During the fire season fire watchmen were allocated for fire preventive measures. There was an alert system using metal pieces. However, there were no fire towers in place. Plantation has been started planting since 1998.with a small scale. Last year 200 acres were planted with grafted rubber seedlings at K 300/-per seedling. If bought from the nursery, it will cost about K 1200/- per seedling. The spacing adopted is 24'x9'. There is altogether 49 staff at the plantation site. No controlled burning was practiced.

10.2.2.2 Padoma Rubber plantation

The extent of oil palm and rubber established at Padoma site is 1000 acres; however only 600 acres survived due to rodents and moles attack. There was

encroachment of fire in the past. In order to prevent from future encroachments, fire lines were constructed with a width of 20 feet. For oil palm, fire lines were constructed for 5 years. Generally, construction of fire lines was completed in January. This year oil palm plantation extent is 150 acres and rubber plantation 200 acres The spacing adopted for Oil palm is 30'x30'x30' in triangular spacing while the spacing for rubber plantation is 20' x 10'. There are altogether 25 staff at Padoma plantation site. The source of Oil palm is from Malaysia. Grafted rubber plantations can be tapped in 3 years time. No backfiring was conducted.

10.2.3 Palm Oil Plantations of Union of Myanmar Economic Holding Limited

Palm Oil plantations were initially established by Sky Link Company in 2001, using plantlets of Caribbean origin. During the era of Sky Link, the extent of established plantations was 4500 acres. Those palm oil plantations were taken over by Perennial Crops Division of Ministry of Agriculture after the Sky Link Company was abolished due to legal prosecution. Since 2003, UMEHL has been taken charge of these plantations and a factory was built for processing of palm oil for soap factories.

At the moment the extent of oil palm plantation has increased to 6, 791 acres with an annual planting target of 300 acres. The plantation areas are mostly of degraded Dry Upper Mixed Deciduous forests with bamboos.



Fig.39 UMEHL Oil Palm plantations

Taungya plantation technique has been adopted and land prepared accordingly for planting with 1 year old oil palm seedlings, raised in the nursery using sprinklers for watering. Water source for the sprinklers are from small checkdams constructed along the streams which will also be used for fire-fighting incase of fire.



Fig 40. Check dams served as water supply as well as for use as firewater in case of fire

Taungya cutting normally starts in January / February and *taungya* burning commence in March / April. There are 3-4 incidences of wildfires encroached into plantations with the causes of fire due to negligence during charcoal making together with arson and accidental fires by hunters.

For this year a new crop will be introduced in place of palm oil using buddedseedlings of rubber for 300 acres as the performance of rubber plantations in the vicinity of the oil palm plantations are quite promising with high market potential than oil palm.



Fig.41. Current year plantation area felled for planting rubber

Though the planting scale is quite massive, they still lack weather station at UMEHL. At the moment rainfall data is received from TNRP upon special request as TNRP has a rainfall recording facilities at their Gangawtaung Office.

According to UMEHL, the most vulnerable season for fire is from March through April just before the onset of the monsoon rain and depending on wind direction and speed, they normally set fire for land preparation between 2.00p.m and 6.00 pm with assistance by a reasonable number of people as fire-watchers for controlling fire in case of jumping into other areas. In order to prevent from escaped fires they normally construct internal firebreaks (12') and external firebreaks (24') with the assistance of bulldozers which also serves as access roads throughout the whole year.

According to UMEHL experience for a couple of years in the Taninthayi area, the most fire-prone forest types is the Mixed Deciduous Forest type where the fire risk is quite high due to the shedding of leaves in the dry season and presence of bamboos.





Fig.42 Internal firebreaks

Fig.43 Road network serves as external fire lines

There is not much threat to oil palm plantations of old-age in terms of fire risk as the weeds are being suppressed by the complete crown cover, compared to young-age plantations which are more susceptible to fire damage when fire sets in. The risk of fire incidence for oil palm plantations is quite low when compared to rubber plantations at this massive scale. However, a significant incidence of fire occurred in 2004 when a plantation of 1200 acres of oil palm was wiped out by fire. There are a few villages at the vicinity of the oil palm plantations and generally the villages are about 1.5 miles to 3 miles far from the plantations. There have been a few cases of arson from villagers nearby due to the activities of hunters and charcoal makers.

In order to refrain from wildfires, fire lookout towers are established one for every 100 acres and fire-watchman are deployed for 24 hours with a provision of wooden-gongs for alerting in case of fire.



Fig.44. A fire lookout tower



Fig. 45. Wooden gong

A draft plan has been developed for fire management and in case of fire provisions are made for the supply of water by facilitating trucks for restoring water in the form of water bowsers for use as fire trucks. Water supply for the fire-water trucks are organized by constructing check dams along the streams. Water pumps are also made available on the trucks to put out fire if in need.

In case of escaped fires from adjoining areas from the plantations communication can be made by using cordless phones, signaling from fire lookout towers, and messengers using motorbikes and the staff and labors are organized to report to the muster point for further action. Organization for fire plan is as follows: for every 300 acres there is 1 supervisor and for every 3-300 acre block, 1 assistant manager is in charge. Likewise, for every 3 blocks a manager is taken care of necessary action.

A fire brigade at Kanbauk village is only 4miles from Oil Palm Farm and if in need, can contact by sending messenger by motorbike, which will take about 15 minutes. The UMEHL staff is in good contact with TNRP and has been receiving seedlings and rainfall data from their rainfall station.

10.3 Oil and Gas Personnel and Installations
One and the only accommodation facility and process area inside the transportation corridor in the TNR is the Metering Station (MS). U Sai Myint Oo (Safety Supervisor) explained that Metering Station (MS) is situated quite close to Ban-Ei-Taung village, about 2 km away from the Myanmar /Thai Border. When asked how great a risk of wildfire for their installation, he replied that the risk pose will be just moderate. In order to protect their installation from potential wildfire incidence they regularly construct firebreaks at the vicinity of the Office/ Dormitory buildings (accommodation areas) as well as the Process Area. He felt that the current situation is 80% safe over the whole premise except the very steep slope area close to helipad at the southern part of the premises which is very risky to climb down.



Fig.46 Frontage of Metering Station

The most recent incidence of wildfire at MS was during December 2010 near MS helipad and the cause of wildfire was due to the New Year balloon festivities on the 31st of December 2010 from Ban-I-Taung village. At about 18:15 hrs one of the balloons landed near MS helipad ditch which was spotted by one of the plant operator and reported to MS Supervisor and he then forwarded to the Site Manager at PLC. Emergency response team (ERC) went to the scene at once and fought the fire. With the assistance of fire truck and fire hydrants the scorching fire spreading in from southeast direction and aggravated by the gusting wind at 10-20 knots was under control at 18:32 hrs and kept on watching the whole night. Nobody was injured and no other damages due to the fire. The incident report was sent to the Site Manager but not reported to TNR personnel so far.



Fig.47. Bush fire at MS on 31st December 2010



Fig.48. Firefighting by MS personnel

Accordingly, in order to suppress potential wildfire incidences, two new fire hydrants were installed to suppress future fires. MS has water storage dam of 270 m³ which serves not only for water supply for MS but also lifeline for fire water supply with fully equipped fire truck stationed at MS. An additional water storage dam with a capacity of 25m³ is also existed close to MS. As the plant is situated on top of a hill surrounded by evergreen forests the risk of wildfire is low as mentioned already except the presence of broom grass close to the installation poses a major threat to wildfire. In order to mitigate and reduce wildfire risk MGTC constructs fire lines along service track (which also acts as additional fire line of 5m width) and also upgrading of fire fighting equipment including the installation of portable fire fighting engine in case of emergency apart from the existing fire truck.

Among the facilities at MS the area where extreme fire hazard lies is the office buildings close to helipad as these buildings are made of wood. An additional hazard is that at very steep slopes the broom grass can not be completely clear cut, due to the concurrent landslide problems to be faced with during the coming rains which are quite heavy and massive. For safety sake firebreaks are constructed at least 6m wide with more safety measures being given to Process Area so by having complete coverage of fire lines encircling the area.



Fig.49. Southern part of helipad of MS where fire balloon had landed



Fig.50. Fire hydrants



Fig.51; Fire extinguishers



Fig.52. MS Process Area at foreground on top of a hill

Due to the previous wildfire incidences happened during the past years all personnel residing at MS are quite aware of wildfire and are well alert in case of wildfire. For firefighting purpose MS has 1 fire truck with a capacity of 4.5 m³ with an emergency water supply from 2 dams, the big dam with 270 m³ and the small dam with 25m³ quite close to MS. Also there are altogether 6 fire hydrants installed inside the premises which when fully operational can last for 5 hours. The fire crew is made up of 6 personnel and all remaining Personnel On Board (POB) are trained to assist the fire crew in case of wildfire. Fire fighting crews

received regular certified training at Marine Institute of Technology (MIT) in Yangon with refresher training course at 5 years interval.



Fig.53. Fire truck and ambulance



Fig.55. A small dam of 25m³



Fig.54 Hose reel system of fire truck



Fig.56. A big dam with 270m³

As the use of service track is restricted to authorized personnel only (i.e., staff and labors from Oil and Gas companies, TNRP and military personnel only) an unexpected case like New Year ceremony at Ban-I-Taung could become one of the causes of wildfire which can threaten MS facilities.

In case of wildfire the voluntary team can make up of 50 persons who are residing at MS. In case of wildfire MS has a system of warning all personnel

through general alarm system for mustering as well as Fire and Gas alarm. A procedure has been in place at MS for prevention of wildfire prepared in 2000.

At the moment the average number of personnel using the service track per day is (55) persons and coming year a lot of labors will be working at the vicinity of service track for gas pipe laying activities from PTTEPI, which will pose up additional risk for the transportation corridor. At the moment tool-box talks were given to labors by HSE personnel for prevention and suppression of wildfires. Also, the Forest Fire Consultant had given presentations and awareness talks about forest fires to those personnel working at the service track from TEPM and PCML

MS has rain gauge station where rainfall data can be obtained while for temperature, wind direction and wind speed they have one Pocket Weather Tracker for providing weather data to communicate with chopper during the landing operation used by Helicopter Landing Officer at MS. Although PCML staffs are staying at MS, TEPM is taking charge of all activities at MS including road maintenance works along the service track. PCML maintenance crews are also working along the service for maintenance of their pipeline and Right of Way.

There is one rainfall station at MS for recording rainfall only. MS control room staff is responsible for recording rainfall data. Along the service track there are also 3 rainfall recording stations where rainfall data is collected and recorded daily by Road Maintenance team and send the data to PLC control room daily. The rainfall data stations are located at Kilo Point Road (KPR) 40 (Block Valve 2), KPR (49) Khotama camp and KPR 59, Kyauklone Gyi camp.



Fig.57. Rain gauge at service track



Fig.58. Rain gauge at MS

The Pocket Weather Tracker has the following capabilities:

- Wind speed
- Temperature
- Wind chill
- Relative humidity
- Heat stress
- Dew point
- Wet bulb temperature
- Barometric pressure, and

• Altitude



Fig.59. Portable weather tracker at MS



Fig.60. Specifications for Portable Weather Tracker

MS is well facilitated with firefighting equipments and trained fire crews that wildfires can be easily handled. Apart from that MS personnel are aware of the value of constructing firebreaks / fire lines as preventive measures from wildfires through their personnel experiences. However, unexpected incidences like wildfire from balloons can happen at any time and what MS authorities have done so far to prevent from such incidences happened again, is by negotiating with village council from Ban-I-Taung with the assistance of authorities from PTTEPI (Thailand) and requested them to refrain from such kind of festivities in future.

In terms of weather data rainfall data can be available from MS or from PLC as daily rainfall data is sent to PLC through daily reports and rainfall data from service track rain gauges are recorded by UE labors every day and reported to PLC on daily basis. MS personal does not record temperature at the moment although they have instruments in hand to record if in need.

During 2010 due to long drought the water supply was not quite sufficient whereas in 2011 due to early rainfall in March water supply was in full load and available is large quantity for firefighting in case of fire.

Concerning external fire protection for MS, Mr. Mark Nishapati, HSE Superintendent had developed a dossier in 2000 March. According to his dossier he expressed that as MS is located in a mountainous heavily forested region, it is physically remote from all fire fighting resources (at least from PLC) and totally dependent on its own fire fighting capabilities. A few fire incidences had been reported in the area around the MS facilities and accordingly the dossier was prepared to consider the risk of such wildfires to MS and the adequacy of its fire fighting facilities in light of that risk.

He mentioned that in terms of general fire risk the MS topography provides a good degree of protection against forest fires. The service track provides a good firebreak to the north of the entire facility, approximately 5m wide. Immediately

opposite the Utility and Process Area to the north, there are also upper and lower lay down areas which provides extensive fire breaks. He also stated that to the west of the process, the area is largely clear due to the TEPM and PCML pipeline tracks, and the west of the utilities area is a largely cleared region between it and the process area.

The east of the utilities area is bounded by the helipad and then a steep cleared region down the service track at this point is eroded with very sparse vegetation. He did mention that the biggest direct risk of forest fire affecting MS is from the south, where no significant segregation exists between the forest and the MS facilities. Even there the vegetation to the south of the utilities area is predominantly grass (broom grass), with the process area being bounded by forest.

According to his risk analysis it is quite certain that the fire incident due to the balloon occurred at the grass land area in the south close to helipad which is the highly risk area and the problem is aggravated due to the absence of fire lines along steep sloping grass land area.

10.4 Military Battalions

Army compounds along the 6000 feet corridor are 282 light infantry near Kawhhlaing village, 307 artillery battalion near Migyaunglaung (O) village and three light infantry battalions, 408, 409, 410 near Kyaukshut village.



Fig. 61 Location of military battalions

These battalions have their own territories and generally extend and develop these areas into farmlands. Normally, they use fire as land preparation tools and there are cases where fire spreads to adjoining areas during the burning process. A fire hotspot data detected on 22-2-12 indicated that the fire hot spots are located near LIB 410 and ground checking made the next day found out that the area extent reached very close to the railway line and some rubber plantations of Kyaukshut village close to the military territory boundary.



Fig.62 Fire hotspot at 23-02-12 as detected from MODIS close to Kyaunshut village and military battalions (fire spread towards the railway line)

The existing vegetation is old *ponzo* with good growth of bamboo and the terrain is very flat, in the drainage of Kysukshut stream as observed from the ground truth and contour map. RMT should provide awareness campaigns for those military camps on how effectively to use fire for land preparations or for controlled use of fire.



Fig.63. Field checking of hot spot data on 24-2-2012



Fig.64. The burn scar area at left and adjoining rubber plantation



Fig.65.Location of the boundary of military battalion boundary



Fig.66 The car track / cart track used as fire line and quite effective for

surface fire

11.0 Forest Fire Risk Analysis

Risk Assessment				
Identifying risk of forest fire	Identifying affected population groups and assets	Identifying reasons for vulnerability of these groups and elements	Description of risks and evaluation of risks (High, medium or low)	
A. Hazards Orchards / plantations close to highly flammable mixed deciduous forests	Villages are highly affected as their homesteads/orchards are quite close to the deciduous forests that are very highly	Poverty, lack of information on forest fire weather situation and no restriction to access are	According to the forest fire hotspots and questionnaire surveys, it was evident that fire incidents were generally existed at	
Access is not restricted with free	sensitive to fire. Orchards owned by	fire at TNR.	the Village Use Zone of TNR where the forest type is	

access	villagers are likely to be seriously affected	Ineffective fire line construction	deciduous type mixed with bamboos.
Hunting activities	Wildlife population decreasing due to hunting	Insufficient fire fighting tools	In accordance with the information mentioned above the following are the category of risk
Opportunities	Soil erosion from	organizational capacity	for the four stakeholders
Adding nutrients to		Limited	
the soil in the form of ash		operational preparedness	1. Communities (including hunters) - High
		Inadequate fire	2. Rubber plantations-
		prevention	Medium
		capability	3. Army battalions -low
			3. UMEHL – low
		Controlled use of	4. O&G Installations –
		fire is not well	Low
		managed	based on,
			tire hazard
		Lack of	fire risk (occurrence)
		alternative	ignition) protection
		Ilveiniood	capabilities
			(infrastructure, road
			systems, fire fighting
			facilities such as fire
			hydrants, fire trucks)
			values economic
			(business, industry) ,
			ecological (biological
			social values
			social values

	(property, cultural etc.)	livestock,
	See details i	n table (6)

Options			
Identification for option	Explanation		
A. Adaptations			
Development of early warning systems	TNR will provide ' <i>Fire Danger Index</i> ' signboards at all LOUs to inform villagers concerning the fire weather situation during the fire season.		
Development of fire lines effectively based on traditional experience	During the 'Workshop on Forest Fire Management' construction of effective fire lines were highlighted for prevention of forest fire incidences.		
Impart basic forest fire knowledge for all stakeholders and even for school children at villages	all According to the questionnaire survey at some villages still are lacking knowledg on forest fire		
B. Mitigations			
Support facilities required for effective suppression as an incentive by TNRP.	The support for necessary fire fighting		
	tools by RMT such as		
	- power water sprayers,		
	 knapsack water sprayers, 		
	- Shovels		
	- Axes		
	- Hoes		

The awarding of Community Forestry Certificates greatly motivate sense of ownership as well as secure land tenure of 30 years for the communities, which greatly enhance the activities for construction of fire lines without any intervention from RMT.

A fire management plan for each and every CF should be initiated based on the sample plan drawn up for 'Yebon CF' under the framework of Community Based Fire Management (CBFiM) program

Forest Fire Management Committees (FFMC) should be organized at all villages based on local communities inclusive of rubber plantations inside TNR.

Introduce Income generation activities at CFs with the involvement of RMT and set aside a certain percentage of funds for fire protection purposes.

Impose community-enforced fines and penalties rather than government legislations even though these regulations should be adhered to.

Initiate reward system for those who report wildfires and support for volunteerism.

- Fire rakes
 - First aid kit' for effective suppression of fire.

One good example from Yebon village is that the whole village joined the construction of fire lines for the Community Forest consisting of 936 acres of natural forests owned by the village, without any consent from TNR which is quite encouraging.

A draft management plan was drawn up for 'Yebon CF' by the Forest Fire Consultant (TNR) as a sample.

Development of FFMC is quite essential for the effective management of Forest Fire Prevention led by communities

It is realized from successful CBFiM projects that a certain funds are set aside, particularly for the prevention and suppression of forest fires.

This will enforce more encouragements for the local people from breaking rules.

This kind of incentive will support close
cooperation between the communities
and RMT.

Prioritization of the options for action	Integration into the Fire Management plan	
The following are the results of the group discussions from the workshop. In order to formulate the 'Prevention of Forest Fire Management' in Taninthavi Nature	Draw up fire management plan taken into consideration the needs of the community, based on their experiences on fire	
Reserve, the following facts should be	1.Introduction	
taken into consideration:	2. Objective	
• The main causes of forest fire in	3. Fire Management Zones	
Taninthayi Nature Reserve is due to	4. Fire Preparedness	
hunting and taungya burning	4.1 Fire Weather	
activities	4.2 Fire Danger Index	
Forest Fire Management	4.3 Prevention	
Committees (FFMC) should be	4.4 Detection	
organized at all villages based on	4.4.1 Ground Patrols	
local communities.	4.5 Fire Fighting Equipment	
Introduce Income generation	4.5.1 Fire Suppression	
activities at CFs with the	4.5.1.1Direct Method	
involvement of RMT and set aside a	4.5.1.2Indirect Method	
certain percentage of funds for fire	5. Fire Management Organization	
protection purposes.	5.1 Management Committee	
• The above mentioned committees	5.2 Fire Crews	
should draw up fire management		

plans that are practical, easy to understand and follow up, based on the active participation of local communities with guidance from RMT. Forest fire protection should be • organized through fire line construction, fire brigades and fire watchers according to the fire management plans. After drawing up the plans, regular drills should be carried out according to the plan. School children took keen interest during Impart basic forest fire knowledge the presentation made at Mayanchaung for all stakeholders and school village. For sustainable fire management, children at villages the future generation should also be informed about the impacts of forest fire.

Reference: Climate Proofing (2011)

Table 6. Wildfire Risk Assessment	of Various Stakeholders
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Elements	Communities	Private	Military	Oil & Gas
		Plantations	Brigades	Installations
1. Fire Hazard	Most fire	Private rubber	Military brigades	Oil and Gas
	occurred at	plantations are	are quite far	installations are

	Village Use Zone	situated inside	away from the	situated at the
	close to TNR	the TNR	TNR boundary;	Myanmar /Thai
	boundary.	boundary, within	except those	border stationed
		3000' corridor)	stationed along	uniquely.
		(need contract	the pipeline	
		with RMT for	corridor.	
		land acquisition		
		and legal rights)		
	(High risk)	(Medium risk)	(Low risk)	(Low risk)
2. Fire Risk	Human cause	Human cause	Very restricted	Very restricted
	with more risk	with limited	access	access
	due to easy	access		
	access	Fire lines	Fire lines close	Fire lines close
	Fire lines limited	sufficient	to their premises	to their premises
	(High risk)	(Low risk)	(Low risk)	(Low risk)
3. Protection	Limited road	Infrastructure,	Infrastructure,	Infrastructure,
Capabilities	access from	close to road	close to road	close to service
	communities	systems, fire	systems, fire	track (permanent
	toward TNR	fighters, fire	fighters	road system, fire
	boundary Very	towers, fire	sufficient,	hydrants along
	difficult to reach	watchman in	patrolling around	the premises, fire
	the fire incidence	place	premises	trucks, trained
	area. Limited fire			fire fighters, and
	fighting facilities			very restricted
				use of fire.
	(High risk)	(Medium risk)	(Low risk)	(Low risk)
4. Values	Home, property,	Home, property,	Military brigades	Oil & Gas are
	business	business (rubber	are situated	quite concerned
	(orchards / CFs)	plantations are	along the Ye-	about the risk of
	and biological	situated within	Dawe road:	fire. They are
	diversity are	3000' from both	except those	also concerning
	situated not far	sides of Ye-	residing along	the value of
	away from	Dawe road. They	the pipeline	biodiversity
	villages,	are quite far	corridor as	inside TNR. That
		away from TNR	security staff.	is the reason
		in the north but	These security	why they are
		quite close in the	staffs are	providing funds

		southern part.	situated in the	for biodiversity
			Core Zone with	conservation in
			the restricted fire	TNR
			use	
	(High risk)	(Medium risk)	(Low risk)	(Low Risk)
Overall Risk	High risk	Medium Risk	Low risk	Low risk

FOREST FIRE MANAGEMENT STRATEGY (TNRP)



Under the CBFiM approach, the front line responsibility for fire detection, prevention and suppression rest with communities. The role of RMT would be to

initiate, support and guide this process through training, provision of legislation and regulatory instruments and providing coordination and back up.

11. Discussion

According to the forest fire risk analysis it is quite sure that among all stakeholders the local communities are quite vulnerable to forest fire incidences compared to all other stakeholders such as private plantations (rubber and Oil palm), military regiments and O&G installations. The reason behind is that all orchards and taungya cultivations of local communities are situated quite close to fire-prone deciduous forests of the buffer zone of TNR. In addition to that the livelihood of the communities is either establishment of orchards or taungya plantations. In doing so, fire has been used extensively as tools for cultivation.



Fig.67. Geographical transect of Yebon village.

The geographical transect of the Village Use Zone is where traditional land use, including agriculture, gathering of forest products are allowed except hunting. However, the current land use reveals that areas in the vicinity of the villages are being occupied with farm lands, fallow lands and remnant forests that has extended quite close to the edge of the boundary of TNR, covering the extent of about 7 km (4 miles) as seen from the geographical transect of Yebon village. It can be clearly seen that the current land use is a complex mixture of horticulture farms, degraded forests, bamboo and fallow lands (Min Thant Zin, 2009).

If you look at fire hotspots in 2010, 2011 and 2012 it can clearly be depicted that fire hotspots occurred during the months of December to April in TNR with more concentrated at the northern part of TNR, particularly, in 2012. In the northern part of Mon ceased-fire area the distribution of hotspots is more concentrated in 2011 as well as 2012 compared to other parts of TNR which is comparatively quite a few.

During 2011 December and 2012 January and February it was observed that taungya burning activities were quite concentrated in Mon ceased-fire area most probably due to the fact that in 2011 rainfall started quite early in January, March and April (with no rain in February) which more or less hindered the taungya burning process in great extent. In order to overcome this taungya buring process, during 2012 the process started quite early in December 2011 followed

by January 2012 and February 2012. In the Mon ceased-fire area majority of the hotspots were found to be in an organized pattern, distributed along Kin stream valley, where the vegetation is deciduous type with bamboo brakes over a relatively flat terrain, as observed from the hotspots over laid on to a contour map of 1:50,000.

Observation from Google Maps of the northern part of TNR portrayed that some villages are existing inside the 'Core Zone' of TNR or very close to the TNR boundary. Also, the road networks can easily be detectable along the valley of Kin stream. Also, rubber plantations can be found in those area using advanced farming techniques such as 'contour bund techniques' which they are quite acquainted within the Mon State for establishing rubber plantations.

Major causes of forest fire as arisen from questionnaire surveys and participatory workshop pointed out that hunting and shifting cultivation are the main causes. Information detected from hotspot data greatly supports the fact that the use of fire to clear land for agriculture and settlements by local communities may be the major cause of forest fire in TNR. However, it is also difficult to distinguish between clearance for cultivation and loss due to escaped fires (wildfires). Moreover, though hunting is emphasized as one of the major threats of forest fires in TNR, the significant impact (underlying causes) cannot be properly

addressed for the time being, as a few, one or two hotspot data can be detectable in remote locations along the Myanmar / Thai border which is quite steep and far away from habitation.

The results of questionnaire survey on use of fire as land preparation techniques greatly supported the fact that over 80% of the interviewees admitted that fire has been used as tool for land preparation.

The two Karen villages, Migyaunglaung (old) and Zinba, resided in that region for more than 200 years. They still practiced shifting cultivation as traditional practice descended from their ancestors. During the past decades, taungya cultivations were practiced in Heinze / Kaleinaung reserve with the permission of the Forest Department in the form of 'Karen Areas' specially allotted to the villages in sufficient area as mentioned in the Working Plans of Heinze/Kaleinaung Reserve Forest in 1926 (Smith, 1927).

Concerning taungya cutting period it was clearly stated that it varies from December as earliest and April as latest before the onset of rains. This clearly coincides with the information received from hotspot data of MODIS from 2010 to 2012.

Fire lines were constructed at all villages and fire line width varies from 6-15 feet. In practice, the width of firebreaks varies from place to place. In general, dimension of these firebreaks can be considered as inadequate in order to confine a surface fire (FAO/UNDP, 1986). It is suggested that fire lines need to have the following dimensions: external firebreaks usually should have a width of 6 to 12 m (18-36 feet) while internal firebreaks vary between 3 to 6 m (9-18 feet).

During the workshop for forest fire management there are some variations concerning fire line width depending on the extent of the individual orchard owners and CF User Groups:

Fire line 25 feet width	(10) %
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Fire line 6-15 feet width (80) %

Fire line 6 feet around the farm (10) %

Determination of the effective width of fire lines needs additional studies in future taken into consideration fuel type, fuel load and topographic features such as slope and aspect with due considerations given to the different vegetation and forest types of TNR.

As far as extent of taungya plantations are concerned according to the questionnaire surveys taungya acreages varied from 1-6 acres only which appears to be at a subsistence scale and not on commercial scale. This seems

to be within a manageable scale for taungya plantation establishment. According to the questionnaire survey there were few fire incidences during the last 10 years period in TNR. Also it was stated that forest fire incidences occurred in the vicinity of TNR were mostly of palm oil plantations and rubber planatations, with quite few in orchards (cashewnut, durian, mangosteen etc.), and Community Forests.

With the initiation of the Community Forestry Program, the area extent for the prevention of fire becomes large scale particularly for the prevention of fires in the natural forests. During the initial stage of Community Forestry Programs communities are quite wandering about the security of land tenure and sense of ownership as well as what kind of responsibility and benefits will accrue for them. The major challenge for Reserve Management Team (RMT) is 'to shift the emphasis from humans as a cause of the problem to humans as the solution'. This situation has been technically accomplished by RMT by allocating forest lands through 'Participatory Mapping Approach' and planning carried out inline with the "bottom up approach". This approach clearly identifies the fact that it is in the form of proactive approach rather than reactive: The traditional approaches will provide solution for predictable anthropogenic fire than unpredictable open fires through controlled ignitions and a fundamental understanding of fire growth

behavior (as driven by weather, fuels and topography) by conducting forest fire awareness presentations / educational programs on ramifications of forest fire.

One outstanding event in terms of community initiatives in fire prevention was the construction of fire lines by the communities without the consent of RMT on voluntary basis in the 'Community Forests' of Yebon village. This initiation was the outcome of the presentation made to Yebon CF user groups by the Project Director about his excursion to WEFCOM, Thailand where villagers made fire line construction at their CF on voluntary basis. This is the effect 'of the people, by the people for the people'. It is also important to recognize that this kind of community involvement is a kind of free and willing participation in activities developed by the actors themselves (empowerment) rather than forced participation (coercion) (Karki, 2002).

It was also reported in the International Workshop on Community Based Fire Management in Asia (RECOFTC, 2001) that the success of CBFiM is achieved where there is:

- Adequate funding
- Adequate training
- A participatory approach, and
- Availability of equipment and techniques.

On the contrary CBFiM has failed where there is:

- Conflict (in land use, political, military)
- Very low economic within the community.



Fig.68. Fire line preparation by Yebon CF User groups on voluntary basis

Community based forest fire management is quite new in Myanmar. Forest fire management is concerned with the following factors as mentioned earlier:

- Prevention.
- Preparedness

- Response
- Recovery



Fig.69. CF User groups preparing fire line construction voluntary in Thailand

Among the four ingredients of forest fire, the first two factors seem to be the most logical and feasible solution for RMT. Among the stakeholders the highest risk, on forest fire i.e., communities will be able to communicate easily with prevention and preparedness within their means through traditional knowledge and proactive action that will be assured through ownership, responsibility and incentives. RMT need to speed up the land allocation processes and pursued for getting land security through CF process for 30 years land lease at other villages in TNR.

Collaborative approaches are deemed necessary as enforcement is not able to solve fire management issues in TNR. Indigenous knowledge on preparedness and prevention is the most effective for implementing CBFiM in TNR rather than traditional suppression practices (Ganz et al., 2000).

One of the exceptional examples of arrangements for fire prevention and suppression in the Bukidnon Forest Incorporated (BFI) plantation site in Mindanao Province, the Philippines, is the application of an integrated system of fire weather warnings, look out towers, crew patrols and a comprehensive equipment cache. A key feature of this project is the close cooperation between the plantation managers and the local community in the matter of forest fires. The cooperation included the provision of assistance in controlled burning to neighboring farmers by plantation employees, payment of incentives to neighbors who report wildfires and support for volunteerism.

During the forest fire management workshop in TNR (2012) the consensus of all workshop participants is that the success of Community Based Fire Management will depend on the following factors;

- Adequate funding: self supporting and not entirely dependant on external funding
- Application of traditional knowledge
- Burning to be led by well experienced person from the village and applied wisely
- Effective fire line width
- Provision of Incentives by RMT (in kind i.e., tools and equipment) and also provision of awards as "No Fire Bonus"
- Directly managed the forest resources by the community

Also during the workshop, the role for development of Forest Fire Management Plan to be drawn up by the villagers with the assistance of RMT is greatly emphasized. During the drawing up of Fire Management Plan the following should be observed:

- Draw up fire management plan taken into consideration the needs of the community, based on their experiences on fire (CBFiM).
- The plan should easily be understandable and easy to follow up by the community in the real time situation.
- Drills should be conducted once every month during the fire season with the active participation of all User Group members of the Community Forests concerned. For improving community skills, trainings for communities on the use of simple tools for fighting fires should also be conducted.

12. RECOMMENDATIONS AND THE WAY FORWARD

12.1. Establish a Forest Fire Management Committee

- 12.1.1 Identify diverse community representatives for the fire management committee (Each village has 2 volunteer firefighting crews and at least one of them should be included in the management committee). The committee should include at least 5 persons, including Village Administrator and / or Chairman of CF.
- 12.1.2 Establish roles and responsibilities of the committee.
- 12.1.3 Identify the fire planning area boundaries (i.e., CF boundary).
- 12.1.4 Identify volunteers (i.e., CF members) in the Fire Management Committeeto assist fire preparedness, prevention and suppression activities(Community plantations as well as natural forests)
- 12.1.5 Develop a timeline for committee meetings and public outreach programs such as fire drills
- 12.1.6 Introduce income generation activities at CFs with the involvement of RMT and set aside a certain percentage of funds for fire protection purposes
- 12.1.7 Develop a plan to monitor activities according to timeline on tasks, incentives and funds

12.2. Review of Forest Fire Capabilities within the Community

Hunting

The following activities are recommended for taking care of Hunting in TNRP

- Totally prohibit hunting in Taninthayi Nature Reserve
- Announce prohibition on hunting at village meetings
- Care must be taken during candle lighting for religious concerns and to mop up the area by removing the sources of fire before leaving the area.

Shifting Cultivation

The following activities are recommended for practicing shifting cultivation in TNR

- Determine the number of persons who will be involved in taungya burning before the actual burning process (CF members are duty bound for such kind of activities: according to the Forest Department Circular 25, 1910; every person who exercises a right in the reserve forest such as CF, to report at once to the nearest Forest Officer or Police Officer, the occurrence of a fire in a reserved forest and assist in extinguishing a fire in any reserved forest).
- Take legal action if burning proceeds without prior permission from the Fire Management Committee at least 2 days in advance.
- Construct fire lines (the width of the fire line should be pre-determined for different forest vegetation types / crop types; in practice, the width of firebreaks varies from place to place). In general, external firebreaks

usually have a width of 6 to 12 m (18-36 feet) while internal firebreaks vary between 3 to 6 m (9-18 feet). (Goldammer, 1986): (determination of the effective width of fire lines need additional studies in future depending on fuel type and load for more effectiveness).

- Fix time for burning (generally during the late evening i.e., around 6 p.m. (when the wind is calm, temperature is low and humidity is relatively high).
- Provide hand-made firefighting tools such as water buckets, portable water sprayers, brooms, and rakes etc. in time by RMT so as to boost up moral for the community; this will reflect the image that RMT is working hand in hand with the community.
- Inform the neighbors as well as village authorities well ahead of the burning time.
- Construct fire towers using locally available materials at designated locations (e.g., wooden poles and thatch as roofing as practiced by UMEHL) and also provide gongs or metal pieces as alarm and alerts.
- Assign sufficient Forest Fire watchmen throughout the forest fire season (at least from 15 January to 30 April before the onset of rains). The effectiveness of ground patrolling in detecting fires is dictated by adequate access. So all possible roads, foot trails should be demarcated on a map and made usable at all times during the fire season. Ground patrolling

should be carried out in areas with the highest risk of fires and personnel should be equipped with reporting forms and maps.

- Organize forest fire suppression teams well in advance. Every member from CF is responsible to join the team.
- Adopt early warning systems for effective prevention of fire, based on forest Fire Weather Information (temperature, humidity, wind speed, wind direction and rainfall) such as 'Fire Danger Index' signboards..
- Organize excursion trips to CF projects with successful income generation activities by RMT for dissemination of knowledge to the User Group members for motivation of income generation activities in villages holding Community Forestry Certificates
- Promote Income generation activities at CFs with the involvement of RMT and set aside a certain percentage of funds for fire protection purposes.
- Present Forest Law and Forest Rules in detail at the villages by RMT / FD to clarify and educate on matters relating to proper use of fire by the villagers.
- Scrutinized presentations and demonstrations on matters relating to forest fire management with RMT and Forest Department concerned (e.g., Forest Department, Dawe District).

 Impart basic forest fire knowledge for all stakeholders and school children at villages (school children took keen interest during the presentation made at Mayanchaung village).

Pre-suppression Planning

- Facilitate village meetings
- Discuss about the plan
- Reflect on community inputs
- Identify community needs and potential activities to address those needs.
- Document all planning activities, needs, resources and recommendations.
- Directly move to the incident area upon hearing the fire alarm (gongs, loud speakers)
- Dispatch knife, hoe, rake and lighter, etc
- During suppression use collective effort of the whole community
- Follow the advice of an experienced person
- Conduct drills regularly on monthly basis

Fire-suppression Techniques

Direct Method

- For mopping up use live branches or water if available
- Use sand if feasible: although fire extinguishers are quite effective they are not feasible for real time situations
- Water pumps are also not quite effective

Indirect Method

- Construct fire lines
- Use natural barriers such as roads, streams, trails as fire breaks
- Conduct back firing (controlled burning): in the event of high fire danger the following equipment should be made available and ready for suppression of forest fire.
 - Shovels
 - Axes
 - Hoes
 - Fire rakes
 - First aid kit

Fire Reporting

In case of fire incidence the following should be the format, minimum requirement, for reporting

• Date and time the fire initiated /occurrence

- Location
- Estimated loss value
- Extinguished time
- Method of suppression used
- Causes of fire
- Dispatch of fire crew

Reporting should be made to the Local Administrator and should send a copy of report to TNRP/ Forest Department, Kaleinaung for proper record keeping and further action.

Drawing up Fire Management Plan

- Draw up fire management plan taken into consideration the needs of the community, based on their experiences on fire with the assistance of RMT .(Community Based Fire Management- CBFiM: use questionnaire survey results and Forest Fire Management Workshop results)
- The plan should easily be understandable and properly followed by the community in the real time situation.
- Drills should be conducted once every moth with the active participation of all User Group members of the Community Forests concerned./ villagers

The success of Community Based Fire Management will depend on the following factors;

- Adequate funding: self supporting and not dependant on external funding
- Application of traditional knowledge
- Burning to be led by well experienced person from the village and applied wisely
- Effective fire line width
- Provision of Incentives (in kind i.e., tools and equipment by RMT)
- Directly management of the forest resources by the community

Fire Management Plan Format

- 1. Introduction
- 2. Objective
- 3. Fire Management Zones
- 4. Fire Preparedness
- 4.1 Fire Weather
- 4.2 Fire Danger Index
- 4.3 Prevention
- 4.4 Detection
- 4.4.1 Ground Patrols

- 4.5 Fire Fighting Equipment
- 4.5.1 Fire Suppression
- 4.5.1.1Direct Method
- 4.5.1.2Indirect Method
- 5. Fire Management Organization
- 5.1 Management Committee
- 5.2 Fire Crews
- 5.3 Training
- 6.0 Local Operating Units
- 7.0 Park Warden Office
- 8.0 Reporting
- 9.0 Miscellaneous

H First Aid Training

First aid training with particular emphasis on how to take care of burns and unconsciousness should be trained by the Fire Department at Kalienaung / Socioeco department, TEPM.

12.3 CONCLUSION

In order to formulate the 'Forest Fire Management Strategy in TNR', consideration should be taken for the following facts:

- Hunting and taungya burning activities.
- Forest fire incidences must be monitored using 'Fire Information for Resources Management System (FIRMS)' using MODIS (MODerate resolution Imaging Spectroradiometer) data by RMT.
- According to MODIS data, the extent of forest fire incidences mainly occurred at the buffer zone area of the western boundary of TNRP: the entire core zone of TNRP is generally devoid of fire incidences except a few incidences occurred in the northern most part of the reserve, most probably, due to the taungya burning practices made by Mon ceased-fire villages, settling in at the flat lands of Kin stream drainage.
- The major causes of spot fires are due to lack of fire lines or inadequate fire lines / fire breaks currently practiced in Taninthayi Nature Reserve Project
- Forest fire when occurred is very difficult to contain / extinguish with locally available fire fighting tools.
- It is quite apparent that prevention of fire is the most practicable solution in the vicinity of TNRP.

- Fire prevention can be assisted with 'fire danger ratings' developed using maximum temperature and humidity data for the determination of safe period for setting fire so as to refrain from uncontrolled fires . RMT should provide digital Temperature / Humidity meters for each Local Operating Unit (LOU) station to assist for the determination of 'fire danger ratings' which will be conveyed to the communities so as to be in time to undergo preventive measures through 'Fire Danger Rating' signboards.
- Hand phones should be made available to all LOUs to have good communication with Kanbauk Office.
- The burn-scar due to forest fire can easily be detectable through ground check with good reliability (using GPS from LOUs) in accessible areas.
- Communities should use fire in a safe and effective manner to improve livelihoods and protect resources. These communities are quite familiar with fire and its uses for traditional livelihood activities such as clearing vegetation for agriculture, improving pastures for grazing, hunting and managing non-timber forest products (NTFPs).
- Analysis of CBFiM and its effectiveness as a fire management approach began in the early 1990s in Southeast Asia. The essential feature for introducing Community Based Fire Management (CBFiM) is that it takes seriously the idea of fire management being *community-based*. It does not include situations where people simply carry out paid work for a fire

control agency or another agency outside the community. Under such an approach, the frontline responsibility for fire detection, prevention and suppression rests with the local communities.

- As the burning incidences in TNR are mostly in the vicinity of villages along the buffer zone, it is advisable to form 'Forest Fire Management Committees- FFMC)' at all villages based on local communities.
- CBFiM stems from local-scale fire management in which traditional or indigenous knowledge plays the major role in informing and undertaking fire management, which is also planned, conducted and controlled by local people. A community will actively participate in this program if they either have sense of ownership or legally recognized tenure rights, including management of land and natural resources completely, such as the recipient of CF certificates.
- Generally, CBFiM is an approach to fire management in which local communities are actively engaged in the development, and in some instances preparedness, prevention, suppression and restoration, into one coordinated process. The implementation, of fire management strategies is designed to prevent, control or utilize fires in ways that will improve their livelihood, health and security.
- The above mentioned FFMC should draw up fire management plans with a participatory approach that are practical, easy to understand and follow

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up with the assistance of RMT by the active participation of local communities. Elements needing support may include: analysis of the fire problem, technical capacity, regulatory framework or logistical assistance

- After drawing up the plans, regular drills should be carried out according to the plan.
- The emphasis on community-based relates not only to participation of community voluntarily, but also to understand community capacity that has been recognized and supported by external agencies such as TNRP/FD (Dawe).
- .RMT should provide essential hand-made tools such as shovels, hoes, fire rakes, first aid kit, power water sprayers, knapsack water sprayers, etc. for fire line construction and suppressing fire.
- RMT should make presentations at villages on "Forest Fire Prevention" for providing knowledge on wildfires for the communities.

Apart from that mentioned above, the following measures should also be taken into consideration:

- Awareness raising and regular consultation among all stakeholders
- Improved coordination and communication among all stakeholders
- Forest fire protection through fire breaks construction, fire watchers and fire brigades.

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APPENDICES

Appendix 1

FOREST FIRE MANAGEMENT PLAN YEBON COMMUNITY FOREST

1. INTRODUCTION

Yebon village is situated in Yebyu Township, Dawe district in Taninthayi Region (Latitude 14⁰ 33' 04.1"N and Longitude 094⁰ 11' 10.4"). It is between milestone 38 and 39 of Ye-Dawe highway. It was established in 1960 with 106 household having a total of 608 persons. The race consists of Karen and Dawe. The livelihood of Yebon village is mostly consists of homesteads, shifting cultivations and trade of non-wood forest products and other trades.

Once Yebon village was situated quite close to buffer area of Taninthayi Nature Reserve and lately it was moved towards Ye-Dawe highway due to security reasons. Due to increase in population (growth rate 3.06%) the requirements for forest products and non-forest products is increasing steadily. In order to get sustained yield of forest and non-forests from the nearby forests and also for the regular water supply, the user group of Yebon village had decided to establish 'Community Forest 'for their village and CF application was forwarded to Director Tanininthayi Forest Division in early 2011. The CF certificate was awarded in 28 July 2011.

Yebon CF is situated in the 1-mile buffer zone of Taninthayi Nature Reserve and lies in compartment 7, 8 and 9 of Luwaing Reserve with a total area of (936) acres. The existing forest of CF consists of a mixture of evergreen forests, mixed deciduous forests and bamboo brakes. The degree to which areas of Yebon CF is prone to forest fire depends on the following factors:

- Humans are the major source of ignition and virtually all fires in Taninthayi Nature Reserve are human activities such as hunting and taungya method of land clearing for cultivation.
- The second factor is the type of vegetation and the last factor is the fire weather conditions.

2. OBJECTIVE

The objective of this fire management plan is to ensure that Yebon CF is prepared in the event of high fire danger.

3. FIRE MANAGEMENT ZONES

Fire management requires knowledge of topography, existing vegetation structure, fuel loads, current atmospheric conditions, location of existing fire breaks, access and water bodies

Yabon CF is divided into three fire management zones based on the following:

- Defensible boundaries (rivers, trails, roads, ridges)
- Accessibility
- Fuel type (evergreen, mixed deciduous forest type, dry dipterocarps and bamboo brakes)

The description of each fire management zone is given below:

Zone 1	Zone 2	Zone 3
 The area is mostly flat 	 The area is undulating 	 The area is very steep

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_			
•	Consists of bamboo	to steep	with gorges
	brakes and dry	 Consists of deciduous 	 Consists of evergreen
	dipterocarps which are	forests which are also	forest which is of low
	highly fire prone	fire prone	fire risk
•	Access is very easy by	 Access is quite difficult 	 Access is very difficult
	Yebon stream	due to steepness of the	due to very steep
		terrain	terrain



Fig.1 Management Map of Community Forests, Yebon, Showing Fire Management Zones

4. FIRE PREPAREDNESS

Fire preparedness is the ability of community's response to fire situations successfully. It comprises activities which improve the state of readiness. These are:

4.1 Fire Weather

A critical component in making decisions is the knowledge of weather conditions. Important weather elements are:

- Rainfall
- Temperature
- Humidity
- Wind speed, and
- Wind direction

The necessary weather information will be supplied from Park Warden's office and relay to Local Operating Units (LOU) depending on seriousness of the weather conditions (particularly wind speed and wind direction forecasted for 3 days ahead from www.accuweather.com) by phone.

4.2 Fire Danger Index (FDI)

Fire Danger Index (FDI) is for expressing fire environment which will determine the ease of ignition, rate of spread, difficulty of control and fire impact. FDI will be calculated at Local Operating Units evaluating using daily temperature at 3 p.m. (15:00 hrs) and humidity%. The status of FDI will be displayed at LOUs at the FDI board.(FDI: Low-Green; Moderate-Yellow; High-Orange; Extreme-Red)

4.3 Prevention

Forest fire prevention embraces a wide range of measures of which the most effective measures is to construct fire lines around or within the CF whereby all combustibles are removed and the mineral soil exposed with the objective of controlling the spread of fire. Hence, all streams and trails within the CF acts as fire breaks in the event of fire. Fire lines have to be constructed along the western boundary of CF. Fire lines will be constructed during second week of January and priority will be given to areas with high risk of fire (bamboo brakes). All User Group members have to participate in the fire line construction operation. Fire lines are to be constructed along the TNR boundary (which overlapped with CF boundary) where bamboo brakes exists rendering high risk of fire.

4.4 Detection

For effective fire detection four CF members have to be assigned as ground patrols.

4.4.1 Ground Patrols

During the fire season all usable roads / tracks, and CF boundaries should be delineated on the map for easy access. Ground patrols also provide a way to have good relationship with plantation owners adjacent to the CF which is critical for the spot fire being spread from their activities. Ground patrolling activity should be carried out in areas with the highest risk of fires (bamboo forests) during fire season.

There are private farms, homesteads and cultivated area quite close to the boundary of CF and should alert and alarm those concerns for safe use of fire during the fire season..

Forest Fire Strategy at Taninthayi Nature Reserve



Fig.2 Map showing cultivation areas, orchards, taungya areas in the vicinity of Community Forest, Yebon

4.5 Fire Fighting Equipment.

Equipment usable for fire fighting and hand tools to be made available at Yebon village are the following:

- Shovels
- Axes
- Firer hook/swatter
- Hoes
- Fire rake
- Brooms(bamboo)
- 20 liter knapsack water sprayers
- Water bucket / Sand bucket

- Lighter (for back firing)
- First-Aid box

These hand tools should be kept at a dedicated place for ease of handling during the fire event (i.e., CF chairman residence/office)

Care should be taken when suppressing wildfire as the terrain is quite steep and once the fire breaks out it is very difficult to contain it. These hand tools need to be acquired and will be located at the residence/office of CF chairman and assigned for fire fighting crews.

4.5.1 Fire-suppression Techniques

4.5.1.1 Direct Method

- For mopping up use live branches or water if available (water is readily available from Byet-ka-than, Shwe-tha-chaung and Wa-byin streams.
- Sand will be used if feasible.
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4.5.1.2 Indirect Method

- Construct fire lines
- Use natural barriers such as roads, streams, trails as fire breaks
- Conduct back firing

Care should be taken when suppressing wildfire as the terrain is quite steep and once the fire breaks out it is very difficult to contain it.

5. FIRE MANAGEMENT ORGANIZATION

The fire management organization of Yebon CF consists of the following:



5.1 Management Committee

There are altogether 54 User Group members in Yebon CF with 5 members acting as management committee. The management committee consists of 5 members which consist of the following:

- 1. Village Administrator
- 2. CF Chairman
- 3. 1 Voluntary fireman
- 4. 2 CF Members

5.2 Fire Crews

All other members should in turn act for fire prevention as well as fire suppression activities (duty roaster on monthly basis during fire season from Jan to May which consists of 30 persons for each rotation for prevention and the whole village for fire suppression)

5.3 Training

There are altogether 5 voluntary firemen in the village. They are trained for 1 month at Fire Department, Kaleinaung. These firemen should train all CF members on basic fire fighting techniques including proper handling of fire fighting tools at least once a year with the assistance of Fire Department, Kaleinaung.

6. Local Operating Unit (TNRP) / FD (Kaleinaung)

The local operating unit is responsible for liaising with the management committee on matters relating to forest fire matters. A Fire Danger Index (FDI) will be displayed in front of the Local Operating Unit at Yebon village. This FDI index will inform the villagers at Yebon whether the weather is susceptible to high risk of fire or not using the fire weather information derived from alignment chart using data on temperature and humidity. RMT staff from LOU will raise awareness programs on the dangers of anthropogenic fire and its impacts on fire management, particularly before the onset of the fire season every year.

7. Park Warden Office

Park Warden office is the main centre for controlling the Forest Fire situation in TNR. Forest Fire weather data will be downloaded at Park Warden office from internet www.accuweather.com. Using temperature / Humidity data, and wind data forest fire weather information will be forecasted 3 days ahead will be relayed to LOUs concerned in case of serious event.

8. Reporting

Reporting on activities such as fire line construction for fire prevention and fire suppression activities should be reported on monthly basis through Local Operating Unit concerned to PW office / FD Kalienaung office.

8.1 Fire reporting format

Particulars	Description
Date and time the fire initiated/	
occurred:	
Location:	
Extinguished time:	
Method of suppression used:	
Causes of Fire:	
Dispatch of fire crew:	

9. Miscellaneous

According to the management plan of Community Forestry for Yebon village, CF members agree for fund raising activities, of which some portion of funds must be set aside for fire management purposes. The funds will be used for acquiring hand-made tools, fire line construction and also for fire controlling activities

Appendix3.

Backfiring techniques

Normally, backfiring techniques are used in crown fires and in very fast spreading intense fires.



In these cases the only safe and accurate technique will be backfiring. If the fire is spreading very fast there will be no opportunity to send the crews and machines near the edge of the fire. In this situation it is best to prepare a fireline far in front of the head of the fire and start backfiring against the main fire at this line.



Source: Handbook on Forest Fire Control (1993)

wind.



The basic rules of backburning can be explained diagramatically.

In hilly or mountainous terrain the best place to start a backfire is just over the top of a hill, away from the slope where the main fire is located.



A fireline of sufficient width to hold the fire must be built in advance of the main fire, or use should be made of natural barriers such as a ridge top or a pre-planned and pre-built firebreak.

Source: Handbook on Forest Fire Control (1993)

Anchor points must be in place prior to firing. Anchor points are the places where lines or barriers on both flanks of the main fire join the line across the front of the fire, examples of which are: a road, a cliff, or a man-made line. Lines along the flanks should be built so that the total area of the fire can be contained when the main fire reaches the backfire.

If the backfire is started too late, the impact of the main fire on the control line may become worse. The objective is to have the backfire drawn into the main fire at a safe distance from the control line.

Concentrations of fuel inside and adjacent to the control line should be scattered or removed, so that there will not be too much radiant heat and / or flames across the line for the resources to contain.

Before the start of the fire, all trees adjacent to the control line should be felled to fall inside and far enough from the line so that a surface fire will not jump outside the line.

The corners between the anchor points and the backfire line should be burnt-out first (these are the points that are the most difficult to hold). Then, the edge of the backfire line is established by burning from the anchor points towards the centre of the control line.

Next, burn from the anchor points downhill along the flanks. Where there is a choice, the backfire should always be started at the top of a slope and ignited towards the bottom, or downhill, to prevent the fire from building up and so that it can be held along the line.



A very slow rate of spread is not desirable with a backfire. On the other hand, a very hot backfire should also be guarded against because this may cause spot fires, jumping, and intense heat.

Source: Handbook on Forest Fire Control (1993)